CIVIL ENGINEERING

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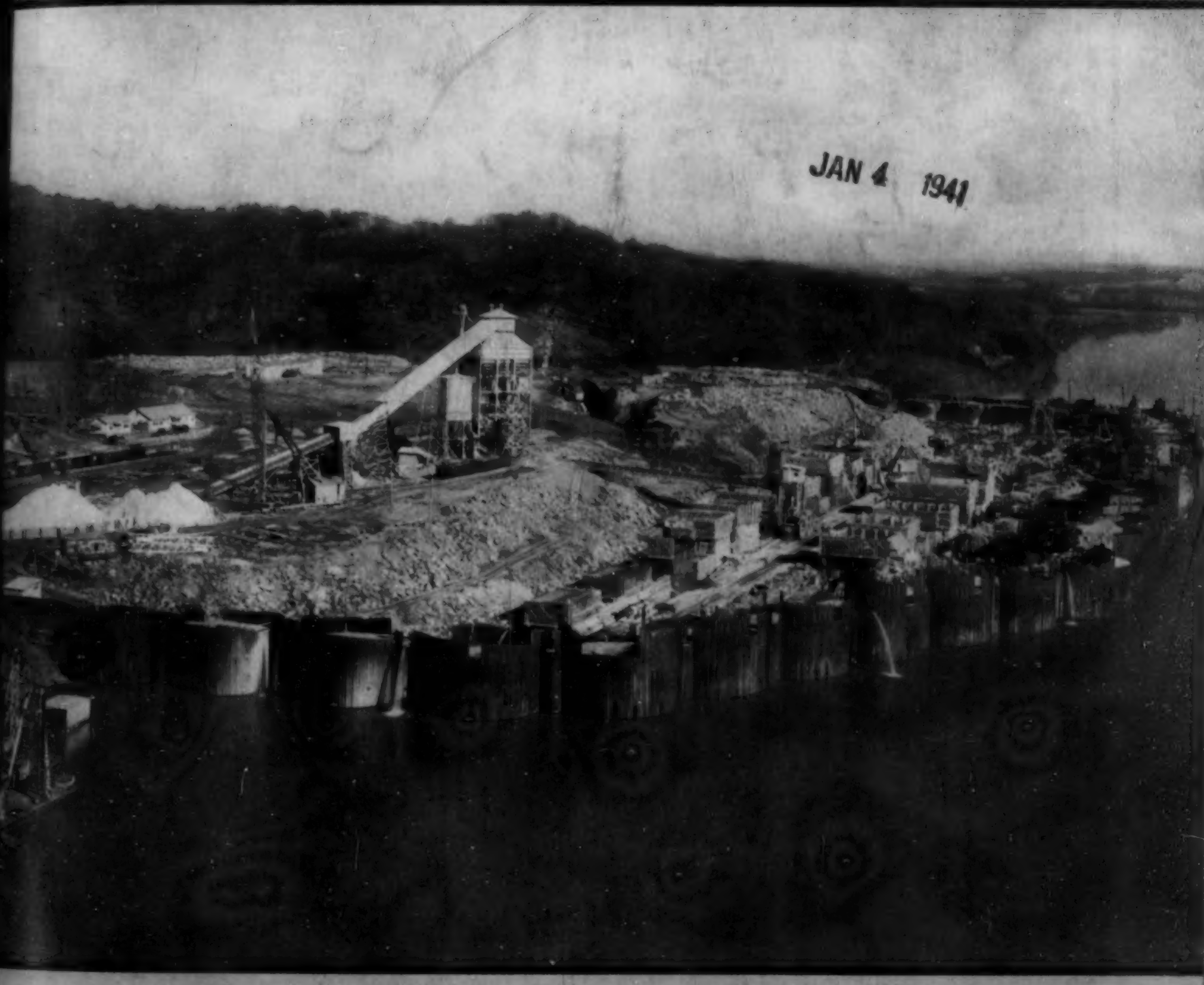

Materials and River Handling Plant at Chickamaugua Dam—See Page 19

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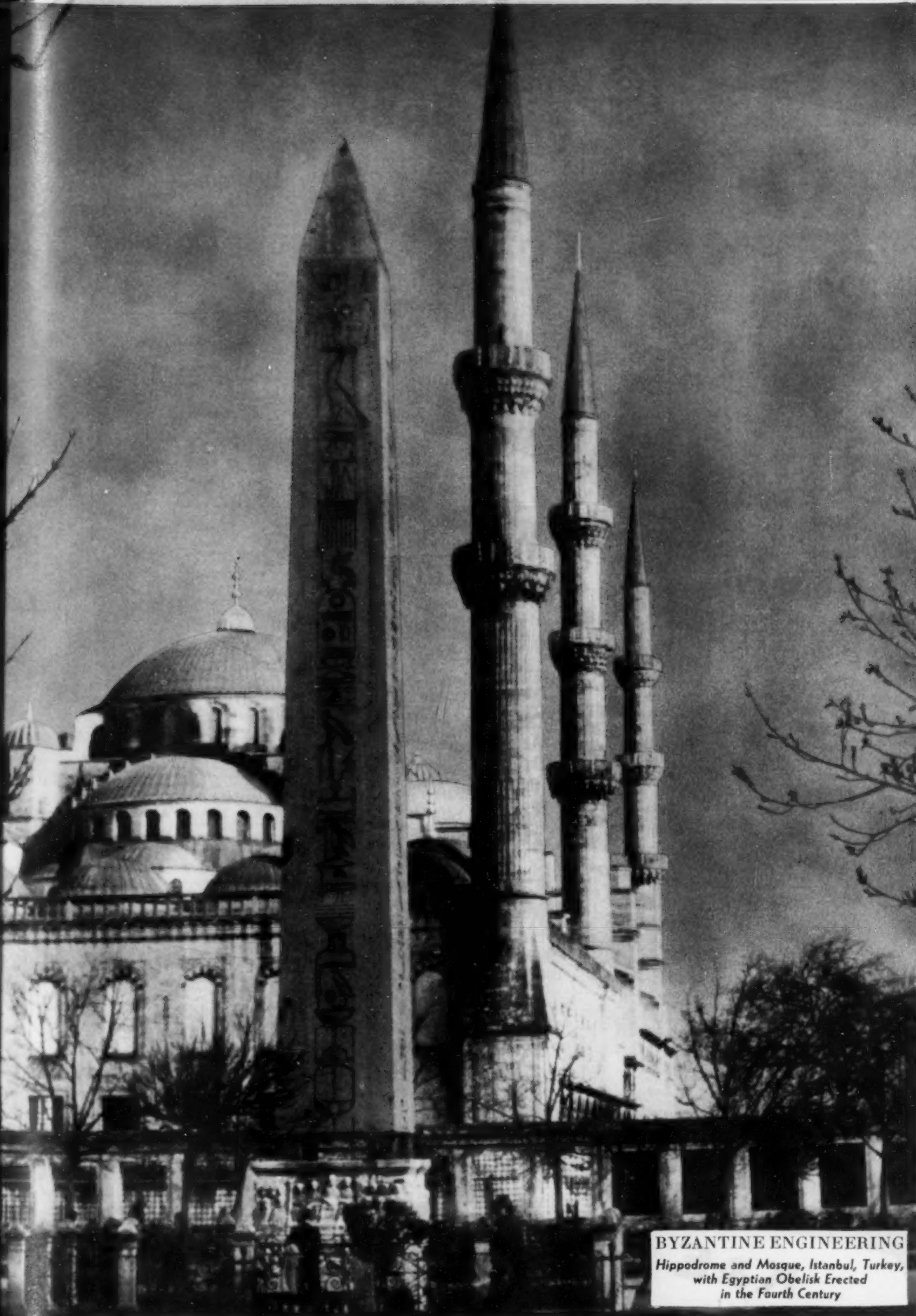

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Among Our Writers

HARVEY N. DAVIS (Brown, 1901) received his initial experience as an instructor of physics at Brown U. After teaching, also physics, at Harvard, he became professor of mechanical engineering in 1918. He accepted his present post at Stevens Inst. of Tech. in 1928. He is a noted contributor to advances in thermodynamics, air compression and steam engineering.

DAVID S. JENKINS (George Washington U., B.S. in C.E.) was employed from 1927 to 1929 by the Mountain Land Company of Denver in water and land litigation. From 1929 to 1935 he served in the Water Resources Branch of the Geological Survey at Denver, Washington, D.C., and Chattanooga. Since 1935 he has been in charge of the Hydrologic Research investigations of the Soil Conservation Service near Waco, Tex.

FRANK M. JOHNSON has supervised the execution of the cadastral survey of the General Land Office in the United States proper and Alaska since the inauguration of the direct system of survey in 1910. Prior to this he was with the U.S. Geological Survey and in private engineering practice in the West.

T. B. PARKER (M.I.T., 1911; M.S. Army Engr. School, 1922) joined the TVA as chief construction engineer in Nov. 1935 and was advanced to his present position in May 1938. End of the World War found him a Captain in the 26th Engineers, and he is now a Lt.-Col. in the Reserve. He has had a long experience in hydroelectric work for the Utah Power and Light, Electric Bond and Share, and Stone and Webster.

IRVING A. JELLY has been employed for over 23 years by The New Jersey Zinc Company. He is now an engineering draftsman at Palmerton, Pa., and is much interested in etching and painting, and in exploring Pennsylvania's old mills, furnaces, and bridges.

JULIAN L. SCHLEY (U.S.M.A., 1903) has headed the Corps of Engineers since 1937. He served in the Philippines in 1904, in the Cuban Pacification in 1906, and in France in 1918. He was an instructor at the U.S.M.A. from 1909 to 1912, and Commandant of the Army Engineer School 1936–1937. Public works assignments throughout the country have supplemented his experience as engineer of maintenance on the Panama Canal, 1928–1932 and Governor of the Canal from 1932 to 1936.

ADOLPH J. ACKERMAN (U. of Wis., E.E. 1926, C.E. 1932) has been in dam and hydroelectric development work that has included earth dams for Fargo Engineering Co. in Michigan, Conowingo and Bartletts Ferry dams by Stone and Webster, and the Calderwood and Chute-à-Caron project for Aluminum Co. of America. He was contractor's chief engineer on Madden Dam, Panama Canal Zone, and head construction plant engineer on TVA projects 1933–1937.

J. CHARLES RATHBUN (U. of Wash., 1903) spent 3 years in the Philippines on structural engineering before becoming Supt. of Bridge Construction for the city of Seattle in 1915. Still earlier he taught in China. Since 1919 he has been a consulting engineer and professor of civil engineering at U. of Wash., S.D. School of Mines, Antioch College, and College of the City of N.Y.

C. FRANK JOHNSON (U. of Ky., B.S.C.E. 1919; C.E. 1938) has been with the Commissioners of Sewerage of Louisville since 1930 on design and construction of sewerage and drainage works. Prior to 1930 he was with the city sanitary engineer's office of Grand Rapids, Mich., for 6 years, and with the city engineer of Paducah, Ky., for 2 years.

RALPH H. CHAMBERS (R.P.I., C.E. and D. Eng.) was formerly chief engineer of Jarrett Chambers Company and The Foundation Company. He has been responsible for the foundations of many important structures including the Standard Oil, General Motors, and Hearst Publications buildings in New York City, the Nebraska State Capitol, and the underpinning of New York Public Library and Trinity Church Tower.

F. V. REAGEL (Ill. Col. and U. of Ill., B.S. in Chem.) was successively jun. and asst. engineer of materials for the Ill. Highway Department between 1918 and 1922. He has held his present position with the Mo. Highway Dept. since 1923 and is active in highway research, being chairman of the Committee on Highway Research Activities of the Amer. Assoc. of State Highway Officials.

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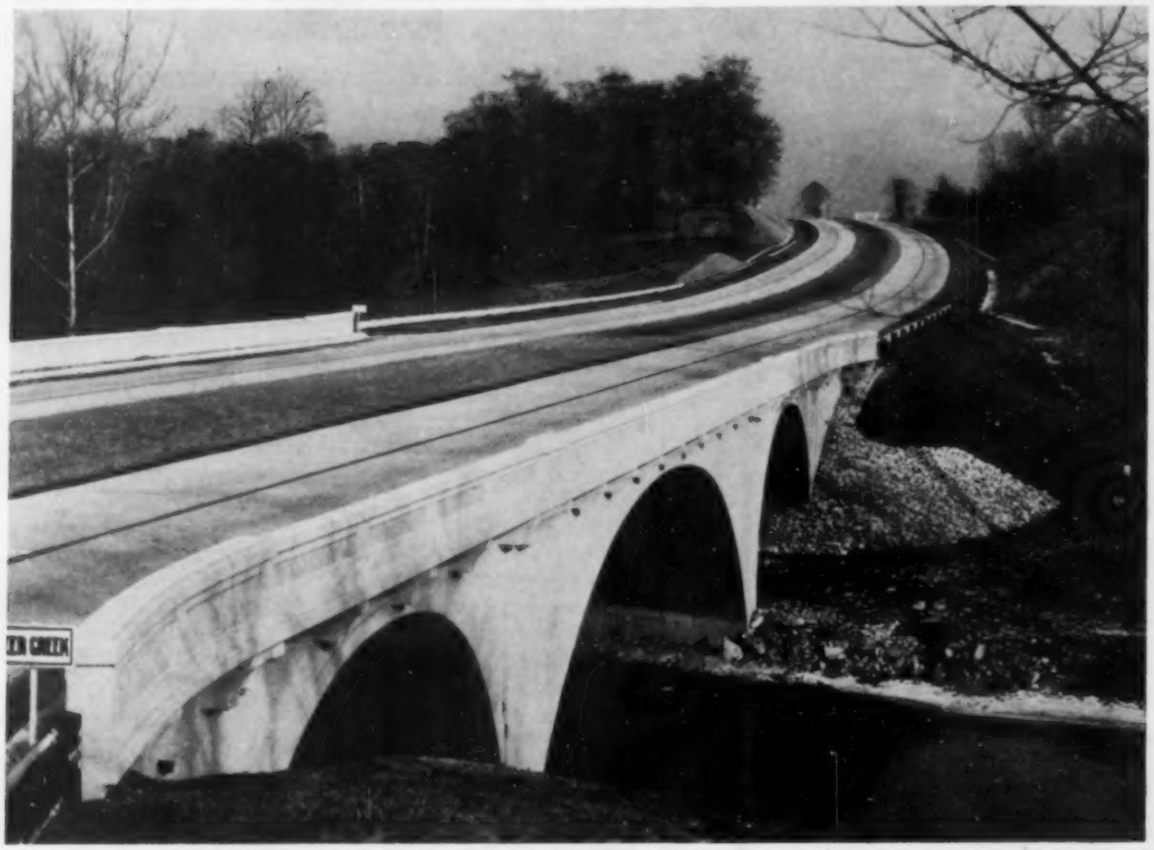

Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Engineers and the Standard of Living

From an Address at the Stevens Institute of Technology 1940 Alumni Dinner

By Harvey N. Davis

President, Stevens Institute of Technology, Hoboken, N.J.
Past-President American Society of Mechanical Engineers

In these troubled times it behooves engineers to do some thinking about the part they are playing, and should play, in maintaining the design for living that Americans believe in and cherish. Our century-old standards have grown out of an interplay of political ideals, such as the Bill of Rights and the concept of democracy, and economic ideals, of which individual initiative and adventurous optimism have been the most significant. While sometimes apparently diverse in their modes of expression, these two sides of our design for living, the political and the economic, are closely interrelated.

Without the Bill of Rights and democracy, individual initiative and adventurous optimism are impossible, as present conditions in the totalitarian nations vividly demonstrate. And conversely, without individual initiative and courageous industrial adventuring, it is highly probable that neither the Bill of Rights nor the democracy that has made us a great and prosperous nation can survive. The great question that confronts us is a choice between a design for living based fundamentally on the ideal of security and one based on the more familiar ideal of vigorous, exciting evolution.

Static or Dynamic Security?~The ideal of security seems, at the moment, to have a striking appeal. In our internal economy we seem to be far more concerned about unemployment insurance than about employment itself. "Thirty dollars every Thursday" is far from a dead issue; and the CCC and the WPA are going strong while industry digs in and lives only from hand to mouth. All this is characteristic of national maturity, not to say senescence. Hitherto it has been chiefly among the older peoples of the world, such as the Chinese and the French, that personal and family security have become the fundamental basis of the philosophy of life among the common people.

Is it possible that we have reached that stage in our evolution as a nation? Have we passed the period in our national development when every mother believes that her new-born son may someday perhaps be the President of the United States; when out of humble bicycle shops in Detroit and Dayton can come ideas destined to revolutionize the transportation and the whole mode of living and thinking of the nation? I cannot believe that the United States has yet crystallized into a nation of security seekers, that individual initiative and courageous adventurous optimism are doomed. I still feel that the best possible sort of security is the dynamic security of vigorous activity rather than the static security of individual and national hibernation.

Living Standards Still High.~Now where can and should the engineer come into the picture? Primarily I think, on the economic side. The most measurable and controllable aspect of the engineer's contribution to modern economic life lies in his power of greatly raising the standard of living of our whole population. Even that "third that is ill-housed, ill-fed, and ill-clad" is only so in comparison with what it might be. It is far better off today—and it was even more so in 1928—than were the corresponding under-privileged groups in the Middle Ages, or those of present-day China, India, Russia, or Germany. Unfortunately most of us, privileged and under-privileged alike, are usually so busy comparing our lots with what we think they ought to be, that we seldom stop to realize and be grateful for what they are.

I admit that the standard of living of a nation is by no means all that is important in determining either its happiness or its contribution to the progress of the human race. Esthetic accomplishments and appreciations, the formulation of sound and inspiring philosophies of life, the perception of and adherence to high ethical ideals, the appreciation of spiritual values—all these are what men really live for. On these are based the deeply durable satisfactions of life.

But I cannot believe that it is inherent in the nature of things that a man must starve in a garret to be an artist, a poet, or a philosopher. Phidias, Aristotle,

Leonardo da Vinci, and Shakespeare all lived in comparatively prosperous countries and in comparatively prosperous periods. Both genius and spiritual nobility are, I believe, more likely to emerge in nations whose standard of living is high than under contrary conditions. Besides, we know very little about how to engender, or even to encourage and develop, either genius or spiritual nobility; but we do know something about the humbler problem of encouraging and developing a still higher standard of living in the United States.

Engineer's Contribution.~To the solution of this problem the engineer brings a particular kind of clear thinking. He cannot help realizing that if we are all to consume more and have more to enjoy, on a per capita basis, we must somehow contrive to produce more, also on a per capita basis. In other words, the engineer starts with the fundamental equation—average standard of living equals total production divided by total population. And he instinctively looks askance at any proposal to increase the value of the fraction by decreasing its numerator.

There is, of course, a type of activity, now increasingly prevalent, that is in apparent contradiction to this rule. In this highly competitive, warlike world, any one minority group can, and often does manage to temporarily improve its own condition by fighting for, and securing, a larger proportion of the total production of the world, even though that total production is itself somewhat reduced by the tactics of the fight. Highway robbery was one of the oldest, one of the most immediately effective and, at times in the world's history, one of the most esteemed, ways of putting this principle into practice. Its weakness, as a socially approvable procedure, lay in the obvious fact that if at any given time, and in any given region, everybody devoted himself to highway robbery, nobody would long have anything of which to be robbed.

Parallels in Our Day.~More modern, more subtle, and often more easily defensible applications of this same philosophy are in evidence all about us today. Unfortunately, every one of them has the same fundamental long-range weakness. When a labor union says that no bricklayer shall lay more than six hundred bricks a day, it is fighting for higher wages and more protracted employment for bricklayers, but the country finds itself with far fewer brick buildings at the end of each decade than it would otherwise have had, and even the bricklayers themselves are, in the long run, worse housed than they might have been.

When an industrial unit maintains a monopoly price and a restricted output instead of taking a smaller unit profit on larger sales, the public has less to consume or to use than it might have had. When the government arranges to have every third row of cotton ploughed under, or every third sack of coffee burned under a boiler, it may be applying a palliative to some temporarily serious agricultural pain, but it is not permanently curing anything, or raising the standard of living of the world as a whole over the years. When one nation invades another, bombs its cities, confiscates its gold reserve, and enslaves its people, a temporarily dominant minority group may perhaps be improving its own lot for the time being but the standard of living of the world as a whole has definitely gone down.

Eventually Only a Net Loss.~The trouble with all these instances of fighting for one's own rights is that in every such case much more is taken away from the rest of the world than the minority group itself acquires. If every minority group sets out to obtain a larger share of the total product by such means, everybody suffers in the long run. Happy only is the group that can do it first, and then by arousing moral indignation prevent anybody else from following its example. Nor does it help the general situation when those who want to do it next argue that because somebody else did it first they have a moral right to take their turn. The only way to resume either industrial or international morality is to resume.

It must be possible to devise some socially desirable way of improving the lot of a minority group that is, at any particular time, relatively "out of luck." Such a way, to be thoroughly sound, would have to involve some increment in total production that could be assigned, in considerable part at least, to the unfortunate group. Something of this sort should and can be worked out for the benefit of labor, whenever labor and management are willing to work and plan together with this fundamental principle in mind.

Similarly with Mechanization.~The mechanization of industry is one of the chief contributions of the engineer to our present high standard of living. It, and its running mate, mass production, have enormously increased our per capita production, and with it, inevitably, our standard of living. But unfortunately each individual step forward in the mechanization of industry, however much advantage it may ultimately bring to the nation as a whole, is almost certain to inflict concentrated hardship on some sharply localized group, which that group will naturally fight to ward off. That has been the history of industrial progress, certainly ever since the industrial revolution of the early eighteen hundreds, and probably long before as well.

One of the greatest needs of the day is the development of far greater wisdom than we now possess with respect to methods of safeguarding the welfare of small minority groups who are injured by what benefits the rest of us. There must be some better way than making them fight for their lives to the obvious disadvantage of all concerned. This problem of how to handle transition dislocations in a socially wise way is one to which both engineers and statesmen must give their serious attention.

A Task for Engineers.~This country needs new industries even more than it needs a good five-cent cigar. New industries mean new factories, new machines, and new capital expenditures generally. Furthermore, these new capital expenditures are the sine qua non of profits in all the old industries, and of what we call prosperity. And finally, prosperity is a very pleasant, even if somewhat dangerous, phase of the economic cycle.

Wouldn't it be pleasant to live a little dangerously once again, with industrial confidence and optimism once more in evidence, with production once more daring to expand and give everybody a chance to work for a living? Unfortunately engineers cannot bring all this to pass alone. But we can at least do our part by pressing forward along the pathway of vigorous, enthusiastic, optimistic research.

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Silt Samplers Compared in Special Tests

Accuracy, Ease of Operation, and Influence of Submersion Period Given Trial on Brazos River near Waco, Tex.

By David S. Jenkins
Hydraulic Engineer, Blacklands Experimental Watershed, Waco, Tex.

Silt sampling, still a young technique, has nevertheless developed into a full-grown branch of civil engineering field work comparable to stream gaging and snow surveying. Instruments for this work have been used and modified by many agencies throughout the country until practice has finally drifted toward the acceptance of a relatively few types. Mr. Jenkins has selected five of these and subjected them to careful and thorough tests designed to evaluate their relative suitability under practical operating conditions.

Adoption of a suitable sampling device by no means solves all the problems encountered in collecting silt records. It is only the first of two equally important phases, the other being the study and selection of reliable methods. Actual experiments to determine suitable methods of sampling are fairly numerous, but additional field tests and research are needed to improve present procedure. The data presented here are confined to tests of instruments representative of five general types of construction illustrated in the accompanying photographs.

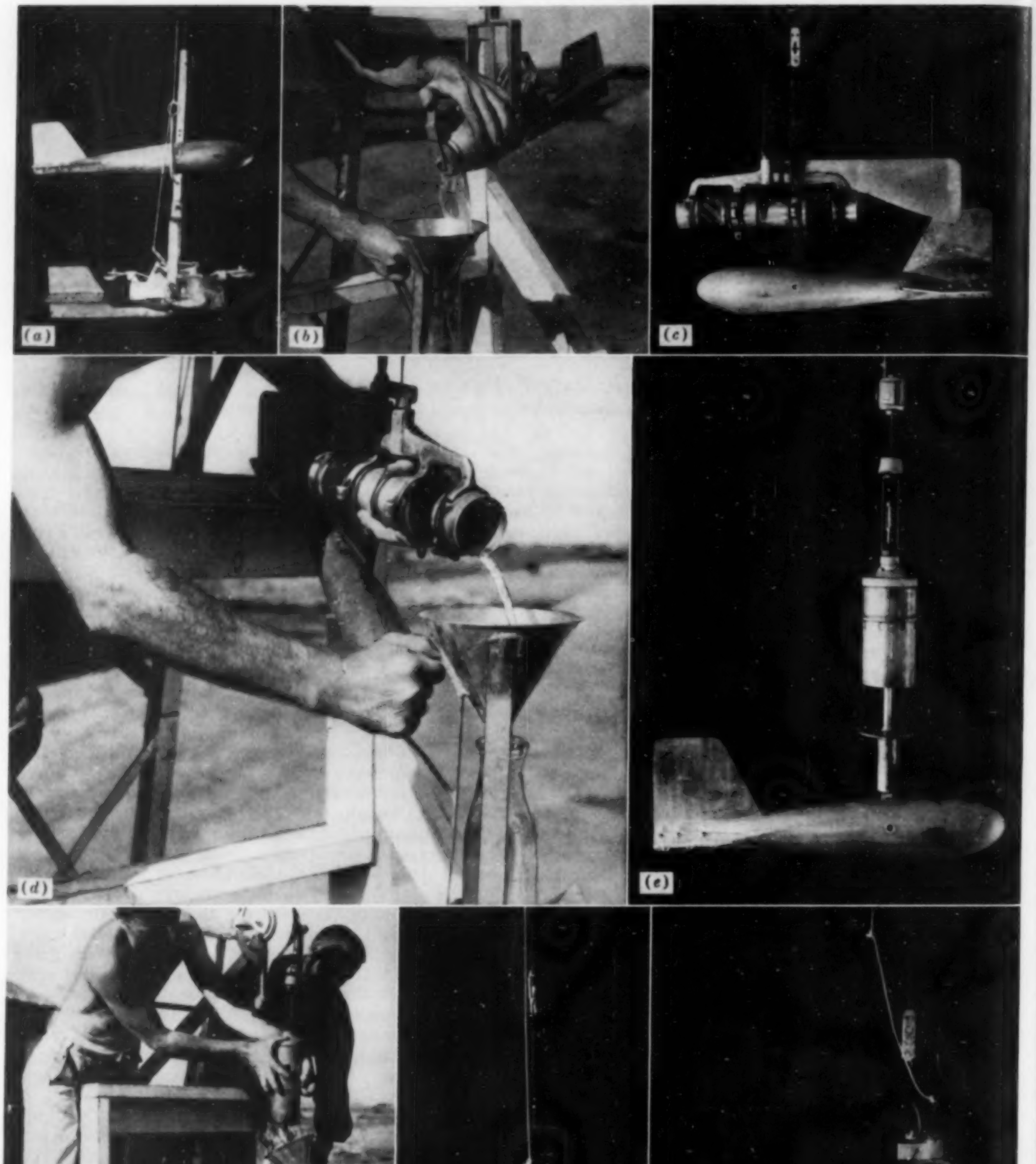
1. *Horizontal tube with exterior valves.* The TVA sampler, which is one of several samplers resulting from considerable research by the Tennessee Valley Authority, is very sturdy and of fairly massive construction. It consists of a weighted cylindrical tube resembling a hollow sounding weight, with an exterior flap valve at each end. The catchment chamber, which is about 2 in. in diameter by 8 in. in length, contains approximately one pint. An auxiliary line is used to trip a trigger which releases the two valves simultaneously, sealing the horizontal catchment chamber. The valves are cocked open before lowering the instrument to the desired depth in the stream. This permits water to flow freely through the cylindrical chamber until the valves are tripped. The sampler has a wide inlet aperture, is considered instantaneous in filling, and requires transfer of the sample to an auxiliary container. The cost, exclusive of weights and bottles, is about $45.

2. *Horizontal tube with interior valves.* The Tait-Binckley sampler consists of a horizontal cylindrical tube in five sections about $2^1/_2$ in. in diameter and about 16 in. in over-all length. The center section of the five, which is the catchment chamber, is about 8 in. long and has a volume of about one pint. (An improved model holds a liter and has ball-bearing guides for the revolving center cylinder.) The second and fourth cylindrical sections are of rubber tubing and constitute the sealing valves. The entire device is lowered into the water, which flows horizontally through the tube until the sampler is tripped by means of an auxiliary line wound around the center catchment chamber. This turns in guides, twisting the two pieces of rubber tubing and sealing the sample. The framework contains a bar from which a sounding weight may be suspended. This sample also is considered to have a wide inlet aperture, and to be instantaneous in filling, and it requires transfer of the sample to an auxiliary container. The cost of the new Binckley sampler, exclusive of weights and bottles, is $125.

3. *Vertical cylinder with sleeve valve.* The Eakin sampler is the result of much study and research by the Division of Sedimentation Studies of the U.S. Soil Conservation Service. It consists of a metal sleeve about 3 in. in diameter and 3 in. long held vertically in the water. It trips onto a thin rubber-covered metal plate by means of a spring trigger actuated by a weight that slides down a suspension cable or rope. A bayonet fastener under the metal plate provides a quick attachment for a bell-shaped weight or a current-meter sounding weight. Like the first two, the device is classified as wide inlet and instantaneous filling, and requires transfer of the sample. An improved model has been made available since the completion of the tests. The cost, including a bell-shaped weight, is about $75.

4. *Wide-mouth bottle.* The U.S. Geological Survey bottle sampler consists of a pint milk bottle held vertically in a weighted metal sleeve suspended on a rope or sounding cable. For these tests a rubber stopper placed in the mouth of the bottle and attached to an auxiliary line was used to prevent entrance of water and silt until the instrument had been placed at the desired depth. This stopper is a departure from the original design which provided for use of this device to collect integrated samples only. There is no provision for sealing the sample after the bottle is filled. The sampler is slow filling, and does not require transfer of the sample. The cost, exclusive of weights and bottles, is about $4.

5. *Narrow-mouth bottle.* The Faris sampler is an 8-oz, round, narrow-neck bottle, held vertically in a light metal cup fastened to a standard current-meter hanger on which a sounding weight can be suspended. The device is hung on a sounding cable or rope. An auxiliary line fastened to a cork or rubber stopper permits removal of the stopper at the desired sampling point. This



Silt Samplers Given Comparative Tests

Types shown are: (a) and (b) TVA (c) and (d) Tait-Binckley (e) and (f) Eakin (g) U.S.G.S. (h) Faris

feature prevents water from entering while the instrument is being placed at the desired depth. There is no provision for sealing the sample after the bottle is filled. It is slow filling and does not require transfer of the sample. Like the previous sampler, the cost without weights and bottles is low—about $1.50.

Of these five samplers all except the Eakin have had the advantage of improvements resulting from use in natural streams. For this reason these tests were somewhat unfair to the Eakin sampler, which had never received this tried and tested development. Other devices studied but not included in this test were the improved milk-bottle sampler used by the U.S. Army Engineers, and the Yuma, Topock, Frazier, Au, Riesbol, Jakuschoff, and Anderson-Einstein samplers.

The two factors considered most important were the accuracy of the samples and their speed and ease of operation.

Accuracy of a sample involves two elements: (1) "representativity" or the similarity of the silt content of the sample to the actual silt content of the water in the stream at the point and time concerned, and (2) consistency with which the apparatus will repeat samples from flowing water of constant density.

As there is no known means of determining the exact quantity of suspended solids in a stream other than by sampling, there is no absolute base to which the results obtained with any one of the devices can be compared. Therefore, to study representativity it was necessary to set up a plan of experiment in which all the instruments were operated simultaneously at various preselected locations and then shifted about according to a prearranged design. Results of the more than 300 tests made in this connection, given in part in Fig. 1, show (1) that the two samples of individual pairs taken with each of the mechanical samplers (Eakin, TVA, or Tait-Binckley) vary more than those taken in the bottles; (2) that samples from the Eakin sampler are consistently low in silt content, possibly due to the persistent leakage, which, being from the bottom of the chamber, may carry the heavier solids away; and (3) the bottle samplers, especially the Faris, appear to collect the most representative samples in that the results from these instruments follow the mean of the group most closely.

As a test of consistency, ten samples were taken as rapidly as possible with a single instrument at a given point in the stream when the stage and silt content was reasonably constant. The results, shown in Fig. 2, indicate that the Faris sampler is the most consistent and that the Eakin is the most erratic.

In much of the work on this experimental watershed, speed of field observations is the essence of a satisfactory record. Its importance is exceeded only by that of accuracy. Many of the watersheds from which records of soil loss are being obtained by manual sampling are so small that the entire duration of runoff is frequently only a few hours. During the rapid rise and fall the silt content may vary several hundred per cent in a few minutes. During one period of runoff from a 170-acre watershed, the silt content changed from 0.2 to 0.5 lb per cu ft between 6:59 a.m. and 7:04 a.m., or about 30% per minute.

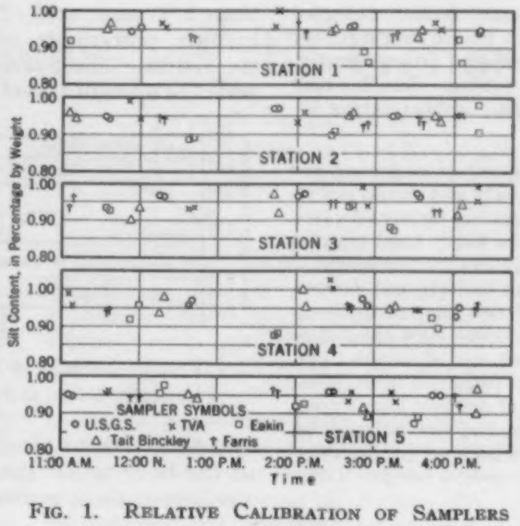


FIG. 1. RELATIVE CALIBRATION OF SAMPLERS
More than 300 Determinations at 0.6 of the Stream Depth

To test the relative speed and ease of operation, the time necessary to obtain the sets of ten samples obtained for the consistency study was recorded. All lost time from delays or breakdowns attributable to the instrument was included in the total elapsed time. The results (Table I) show that ease of operation (time of operation less time for filling) is about equal among all samplers except the Eakin, while speed of operation (total time) is greater for the Faris and the Eakin.

LOG OF TEST PERFORMANCE

A record of breakdowns and delays was kept during all the tests. Some of these may be suggestive of typical performance and are given here as recorded.

TVA: Valves did not close. Put more tension in spring. Closing spring between valves broke; 4 minutes to repair. Valves failed to seal. Was O.K. on retake. Tripping cord tangles badly around suspension line as sampler twists while being lowered. Helpers instructed to stand well to one side and to keep tripping lines taut to prevent twisting. Sampler tripped accidentally because of too much tension on trip cord. Transfer of sample rapid and thorough. One man can do this satisfactorily. Trip cord tangled on suspension line.

Tait-Binckley: On transfer of sample, water runs out of both ends. Put third man with crew to tilt entire equipment, to cause water to run out of one end only. Bearings had to be loosened and oiled. Trip cord tangled. Thirty-pound weight insufficient to prevent trip line from raising entire equipment. Installed 50-lb

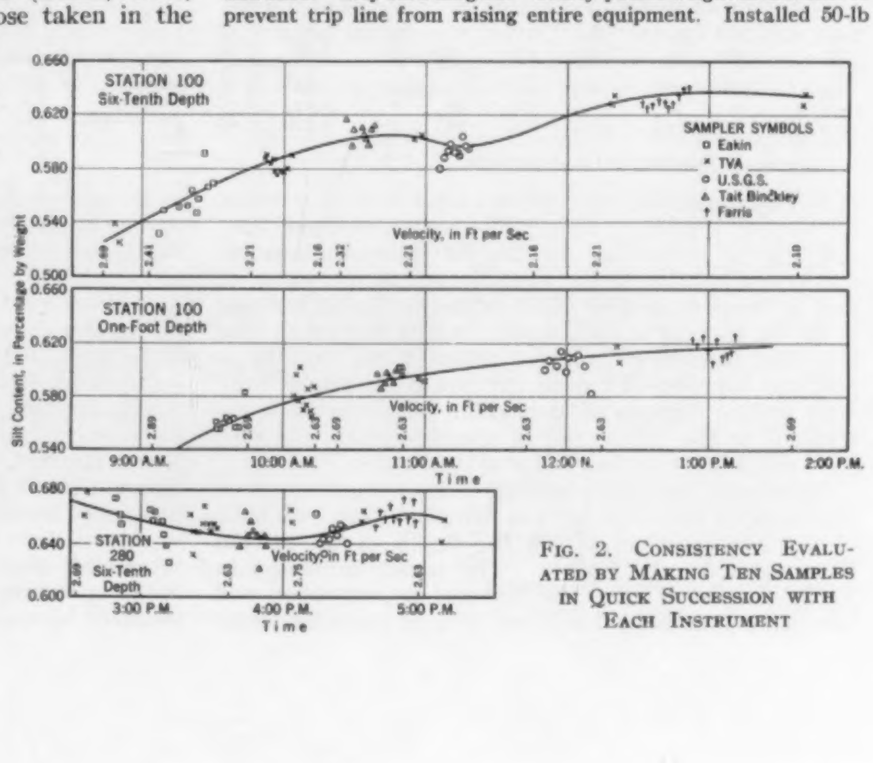


FIG. 2. CONSISTENCY EVALUATED BY MAKING TEN SAMPLES IN QUICK SUCCESSION WITH EACH INSTRUMENT

weight which was satisfactory. Trip cord broke. Installed heavier cord. Grit cleaned out of bearings. Found twig in rubber valve but sample was intact. Trip cord tangled around suspension line. Some silt is lodging in rubber tubing. Samples may be somewhat low in content because of this. Rubber tubing beginning to crack but still intact.

Eakin: Sleeve would not slide; 6 minutes lost in freeing and oiling it although it had been working properly and should not require oil. Sample leaked out, sleeve not bearing tightly on plate. Repaired. Sleeve bound again; 2 minutes lost. Lead tripping weight becoming badly battered. Tied tripping cord to weight to reduce fall. Sleeve failed to trip, slid about halfway and stopped. Part of sample lost owing to inability of two men to discharge sample. Additional helper provided. Tripping cord tangled on suspension line. Twig under sleeve caused loss of sample. Repeated. Sleeve rebounded from plate and remained open, losing sample. Tripping weight broke in two, and one-half lost in river. Substitute weight installed. All water leaked out on way up. Repeated sample which was O.K. Spent 8 minutes getting sleeve to slide although it was working in shop 30 minutes before. Lower plate bent by use, sample leaks out.

U.S.G.S.: Bottle pulled out of frame by trip cord and lost in river. Stopper was apparently too tight. Trip cord tangles and winds around suspension line as sampler twists while being lowered Stopper pulled out prematurely. Too much tension on trip line trying to prevent line from winding up on suspension line. Two bottles pulled out of frame and lost in river consecutively—third one O.K.

Faris: Trip cord tangled, winds around suspension line. Cork pulled out too soon because of tension on trip cord needed to prevent winding up on line. Corks popping out of Faris bottles containing samples, sun apparently expanding air in bottles. (Keep in a cool place.)

The effect of holding open bottle-type samplers in the water after filling was also investigated by lowering empty corked bottles in U.S.G.S. and Faris-type samplers to a 1-ft depth, removing the stopper, and leaving the bottles in the water various lengths of time, some purposely too short to fill the bottle, and some longer than necessary for filling. Additional information was obtained by immersing open bottles filled with clear water for various lengths of time. The results of these tests (see Fig. 3) show that, for the silt concentrations encountered, holding of the open bottles in the water as long as 90 seconds after filling causes negligible increase in the silt content of the sample. It is of interest to note that the clear-water samples gathered silt rapidly at first and approached the silt content of the stream only after several minutes of immersion. The change is attributed to the differential in specific gravity between river water and the clear water in the bottles.

TABLE I. TIME REQUIRED TO COLLECT TEN SAMPLES

(*a*) Total Time in Minutes; (*b*) Total Time Less Filling Time, in Minutes

	Sta. 100, at 0.6 of Stream Depth		Sta. 100, at 1-Ft Depth		Sta. 280, at 0.6 of Stream Depth		Average Time per Sample	
Sampler	(*a*)	(*b*)*	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)
Eakin . . .	24	24	9 1/2	9 1/2	21	21	1.82	1.82
TVA . . .	10	10	5 1/2	5 1/2	8	8	0.78	0.78
Tait-Binckley .	9	9	8 1/2	8 1/2	8	8	0.85	0.85
U.S.G.S. . .	10	9	7 1/2	5 1/2	10	8	0.92	0.75
Faris . . .	17	10 1/2	14 1/2	7 1/2	15	7 1/2	1.22	0.85

* Faris sampler required 35 to 45 sec for filling; U.S.G.S., 8 to 15 sec.

Mechanical analysis was made of five composites, each consisting of the solids from 15 samples taken with each of the five samplers at 0.6 the depth of the stream measured from the surface. The results tabulated in Table II show (1) that the material in suspension was very fine, containing less than 10% of particles larger than 0.05 mm, and (2) the TVA sampler collected the highest percentage of coarser solids and the Eakin the lowest. The valves of the TVA sampler may impede the upward travel of heavy solids in turbulent water and deflect them into the instrument, while the leakage at the bottom of the Eakin sampler may account for the loss of these heavier particles from those samples.

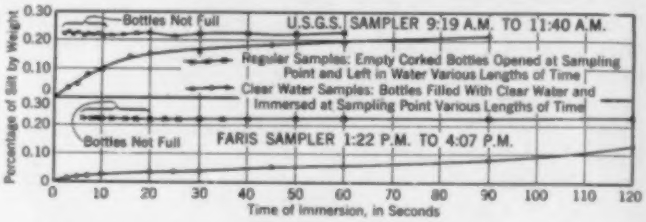


FIG. 3. EFFECTS OF IMMERSION TIME ON CALIBRATION
Samples Taken at 1-Ft Depth; Velocity, 3 Ft per Sec

SIGNIFICANCE OF THE RESULTS

Careful interpretation of the entire program has led to the following conclusions:

1. A sampler that collects its contents slowly integrates and damps out the effect of the flow pulsations that would cause variations in the homogeneity of the silt concentrations, and produces samples more representative than those obtained with mechanical devices that operate instantaneously.
2. Any sampler that requires transfer of the sample to an auxiliary container is less desirable than the bottle-type sampler from the standpoint of field operation, because of the danger of losing part of the sample on transfer.
3. For silt concentrations up to 0.25% of rather fine solids, excessive time of immersion of the bottle sampler after filling does not cause significant increase in the silt content.
4. For streams carrying 1% silt by weight or less, and in which the rate of change of silt content is negligible within a period of 30 to 45 sec, the Faris sampler appears to be entirely satisfactory. For streams in which the change in silt content is very rapid, such as those of the Blacklands experimental watershed, the U.S.G.S. sampler, which fills in about 10 sec, appears more desirable than the Faris.

TABLE II. MECHANICAL ANALYSIS OF 15 SAMPLE COMPOSITES TAKEN AT SIX-TENTHS OF STREAM DEPTH

(Total Silt Content in Percentage by Weight Is Given in Fig. 1)

Sampler	Debris	Larger Than 0.1 Mm	0.1–0.05 Mm	0.05 Mm or Larger	0.05–0.002 Mm	Smaller Than 0.002 Mm
Faris	0.2	1.3	3.9	5.2	41.7	52.9
U.S.G.S.	0.2	1.4	4.1	5.5	40.6	53.7
Tait-Binckley	0.2	1.1	4.0	5.1	41.0	53.7
TVA	0.4	1.9	5.5	7.4	38.6	53.6
Eakin	0.4	1.1	3.0	4.1	39.5	56.0

The experiment was conceived and promoted by the writer. Valuable suggestions were made by C. E. Ramser, M. Am. Soc. C.E., chief, Hydrologic Division; A. E. Brandt, acting chief, Division of Conservation Experiment Stations; and H. R. Leach, H. L. Cook, L. L. Harrold, Joe W. Johnson, and the late Glenn Holmes, all of the Washington offices of the Soil Conservation Service and members of the Society. The work was done under the general supervision of Ralph W. Baird, project supervisor, and valuable assistance in the operation of samplers and analysis of samples was rendered by many others of the staff.

Cadastral Surveys of the General Land Office

By Frank M. Johnson

Member American Society of Civil Engineers

U.S. Supervisor of Surveys, General Land Office, Department of the Interior, Denver, Colo.

In 1812 the real estate activities of the federal government assumed such proportions that it was necessary to organize a special bureau in the Treasury Department to handle them—the General Land Office. Transferred to the Department of the Interior in 1849, this Office became the government's principal agency in the swift development of the West. In recent years it has been charged with much work in retracing old surveys and in defining and recording lands withdrawn from private ownership in connection with the national program of conservation, rehabilitation, and use of natural resources. Mr. Johnson's original paper was presented before the Surveying and Mapping Division at the Denver Convention of the Society.

It is said by students of American history and government that there is no bureau of the federal service whose cooperation is necessary in so many governmental activities as the General Land Office. This has been true practically from the beginning, and unquestionably it is true today on a wider scale than ever before. The reason of course is found in the bureau's basic functions of surveying, managing, and disposing of lands in the public domain under the laws and policies that have governed this work. Cadastral survey and records have been necessary throughout the years to a steadily increasing number of governmental activities, and today they are essential to all agencies concerned with the national program of conservation, rehabilitation, and use of the natural resources.

The public domain came into being with the cession to the federal government by the original states of the region relinquished by England under the treaty of 1783, lying between the Allegheny Mountains and the Mississippi River north of 31° north latitude. This territory was encumbered with no conditions except that it should be held, used, and disposed of for the common good of the nation. By purchase with the common fund and by treaty, additions were made until it extended to the northern line of Mexico, to the Pacific Ocean, and to the polar sea, embracing an area of nearly three million square miles.

In its early years the young nation had practically no income to use for financing public enterprise other than that derived from selling its public lands, part and parcel, to all comers. Land was its most plentiful possession, almost its only possession, and apparently was without limit. On this hypothesis, for more than a century, the public domain served as the original source of national prosperity and the spring and reservoir of material wealth. Today, because of the open-handed policies of the past in its sale, donation, grant, and gift, there remains only a remnant of what once included most of the nation from ocean to ocean. Yet today under our national conservation policies the General Land Office is busier in many directions, and is concerned with far greater recognizable values, than it was in the years when the public domain was at its broadest extent. Nevertheless at times we are tempted to ponder on how differently much of our national wealth in land might have been distributed could our forefathers have caught even a glimpse of the not-so-distant future.

The Solar Compass Used on Early Surveys of the Public Lands, Was Introduced in 1836 by William A. Burt

The policy of land distribution was authorized by the Continental Congress in its now famous ordinance of 1785, in which was also embodied a scheme of survey out of which grew the present highly developed system of surveying the public lands. Disposal commenced immediately, and in 1789 this function was formally taken over by the Secretary of the Treasury. In 1812 the government's real estate activities assumed such proportions that a special bureau was organized in the Treasury Department to handle it; this was the origin of the General Land Office.

Other sources of national income soon developed, and during the 1830's land began to assume a very different role in the national economy from that of supplying cash income. Agriculture acquired growing importance in the outlook for the future. But population was needed, and finally settlement was decided upon as a sufficient compensation for the award of land. To meet the changed conditions the General Land Office, whose operations were rapidly broadening and increasing in complexity, was reorganized in 1836, and in 1839 was transferred to the Department of the Interior, where after the enactment of the Homestead Law in 1862 it became the government's principal agency in the swift development of the West.

In recent times conditions and policies relating to the public lands have undergone fundamental changes, and the General Land Office is again being reorganized along modern lines to enable it better to perform its usual functions as well as to meet the requirements of the new land utilization policies. In this great undertaking surveying is a basic function. In 1910 the set-up for this was changed from the antiquated, inadequate contract method to the direct system later known as the cadastral engineering service.

The question is sometimes asked: What are cadastral surveys and what is their purpose?

Cadastral surveys of the General Land Office, in contradistinction to information and construction surveys, are made primarily for jurisdictional and proprietary purposes. They identify lands by subdivisions upon the ground and by explanatory data in the records, define political and private land boundaries and determine area. Such surveys by reason of their purpose are inseparably associated with the public domain, and as prerequisite to geographical location, description, and title are fundamental factors in the formulation and operation of laws and

Famous Old Triangulation Station—Hallet's Peak on the Continental Divide, Rocky Mountain National Park, Colorado

policies relating to the public lands and therefore in a very definite sense in the orderly administration of natural resources. Our work on the public lands is cadastral engineering in its fullest sense.

The direction and extent of survey expansion and restoration is regulated by law and governmental policy to meet the legitimate needs of location, description, title, and use. For a hundred years agricultural settlement in the Mississippi drainage basin constituted the primary, and at times almost the sole, reason for survey expansion. As the tide of emigration moved westward to the Pacific Coast and Alaska, newer surveying activities began to share with agriculture the necessities of location, description, and title in terms of General Land Office surveys—railroads, Spanish grants, Indian and other reservations, and state boundaries, to mention a few.

About the time lands suitable for farming under the settlement laws were beginning to dwindle, other needs for survey expansion and restoration were originating in the withdrawal of large areas for forestry, parks, reclamation, power, oil and gas development, geological exploration, soil and timber research, water investigations, and many similar purposes. One of the major activities of the General Land Office is the resurvey under the act of 1909, of lands where the original contract surveys are found to be faulty, obliterated or inadequate for present-day purposes. Also, in the mining states, the mineral leasing act of 1920 is responsible for a moderate volume of surveys for patent.

The General Land Office is the only Congressionally constituted agency charged with the execution of cadastral surveys and resurveys on the public lands. It is not always understood that original surveys do not ascertain boundaries, but instead create legal subdivisions. This apparently minor distinction can be very important in certain situations.

In the execution of cadastral surveys there are two major procedures—the creation and marking of the survey lines on the ground, and the preparation of the official record. The additional step of approval and acceptance by competent authority is necessary under the law to give such surveys their official and legal standing.

The final survey record consists of field notes, describing in detail the processes of survey and the results on the ground, and the plat, which is a graphic representation of the surveys prepared from the field notes. The originals of all records, field notes, and plats are filed in the United States public survey offices in the 11 active western public land states and in Alaska, and in state offices in the inactive states, and duplicates are on file in the General Land Office at Washington. The primary purpose of the plat is to show the courses and lengths of survey lines and incidentally topography, drainage, and culture. Its basic function is to designate and describe areas within its borders in specific terms and to serve as the legal basis for all transactions involving the public lands. This legal significance of the plat is as important as though incorporated into the original land patent or deed.

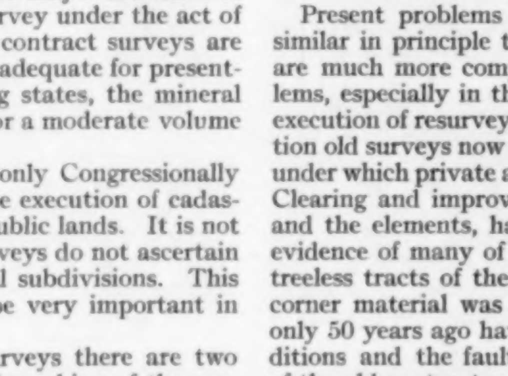
In general the regular plats of an original survey are readily interpreted by the public and by government officials having occasion to consult them, but those of certain types of fragmentary and irregular surveys, and especially of resurveys, are necessarily complicated. Resurveys with tract segregations frequently show conflicts due to conditions of hiatus and overlap and other forms of error in the old surveys.

The admonition of the resurvey acts that no resurvey shall be made so as to impair the bona fide rights of land claimants applies as much to the maintenance of adequate records as it does to proper field methods. Constant study of suitable methods for providing competent descriptions has largely standardized this phase of the work, but it nevertheless follows that many of the more complicated plats may need to be interpreted by experienced engineers or clerical specialists.

Each of the thousands of mineral surveys has an official plat, likewise the numerous homestead entry surveys and irregular tracts of every description. Moreover, plats amending original descriptions are required for many reasons—chiefly for showing new public land lottings resulting from the segregation of mineral or other irregular surveys or a further subdivision of existing lottings. These plats are prepared either from field surveys or, when appropriate, from office records, and in all cases copies are filed in the usual official places.

RESURVEYS INVOLVE COMPLEX LEGAL PROBLEMS

Present problems of cadastral engineering, although similar in principle to some of an earlier day, naturally are much more complex. The more complicated problems, especially in their legal aspects, are found in the execution of resurveys—in restoring to their original position old surveys now obliterated or otherwise inadequate, under which private as well as government land is defined. Clearing and improvement of the land, as well as time and the elements, have destroyed the original physical evidence of many of the very early surveys, and on the treeless tracts of the western country, where perishable corner material was often employed, even markings of only 50 years ago have largely disappeared. These conditions and the faulty and fictitious character of many of the old contract surveys, are not infrequently brought to light by conservation activities requiring area identification in terms of the original or official General Land Office survey, to serve as bases for administration, exchange, and lease.



Dog Teams Supplied the Field Camps on the Survey of Boundaries for McKinley National Park, Alaska

Occasionally it develops that an area has been returned as surveyed under the contract system—as evidenced by plats of record, on which lands have been disposed of and rights acquired, all as though fully authentic—when field investigations show that the survey was never made in fact. Fortunately such areas constitute only a frac-

Monument No. 1 on Boundary of McKinley National Park, Alaska

tional percentage of the whole. The problems involved in the recovery of the legal survey in such localities require in their solution the employment of much more than technical surveying procedure. The legal rights of the government, the state, and individuals must be considered and then defined later by resurvey processes. In case of serious conflict, such work necessitates the making of reconnaissance surveys and comprehensive field investigations, accompanied by reports and maps for further engineering and legal consideration, or for use as exhibits in boundary suits before the courts. For it will be remembered that cadastral surveys—unlike purely scientific surveys of an informative character, which may be amended with changing conditions or because of error—mark for all time the legal boundaries of the lands.

An approved official survey may be physically lost or in error, or fraudulent in whole or in part, but it still is the only basis on which boundaries and area are defined for all time with descriptive fixity of place. In making resurveys under such conditions it is our problem, in effect, to supply something that never existed physically, and to protect all valid rights in the process.

MANY PARTIES NOW IN FIELD

New developments are continually taking place in connection with conservation. The contrast between the present purpose of cadastral surveys and that when disposal rather than conservation was the basic theory, may be seen in the following excerpt from my report to the Commissioner in discussing appropriations for work on which about 80 field parties are now engaged:

"The more extensive and important projects scheduled for 1941 are on the public range in western states under the Taylor Grazing Act and on the national parks and forests in all parts of the country, including Alaska. Other areas in the same category, but of lesser extent, include Indian Reservations, reclamation withdrawals, and regions valuable for their mineral, timber, watershed, wild life and recreational resources. Surveys and resurveys also will be made of lands applied for by individuals under various laws and by the states, and of a wide range of miscellaneous tracts including home sites and Section 15 lands under the Taylor Act. In addition engineering field investigations will be made of old survey conditions for use as evidence in suits before the courts and to develop data for resurveys."

Through the processes of the public land survey system, in the 152 years of its operation, over a billion and a quarter acres of the public domain, whose territory embraces about 79% of the United States proper, and Alaska, have been surveyed under 35 principal meridians and base lines. This area includes 18 states surveyed practically in their entirety, and 11 states approximately 90% of whose combined area has been covered by the rectangular net. In the territory of the public domain dwell nearly sixty million people, and its real and potential wealth is untold. In this vast area, with few exceptions, title to privately owned land passed in the first instance direct from the United States under its various land laws, with descriptions in terms of the cadastral survey of the General Land Office.

In more recent years the United States has rapidly become an extensive land owner as a proprietor of those areas of the public domain that have not passed into private ownership, and by repurchase where conservation plans demand administration in units too large for individual enterprise. Practical administration and long-range reclamation of these national areas for conservation require complete title records and land descriptions, including marking of lines on the ground, and dealing with adjoining owners on questions of boundary location.

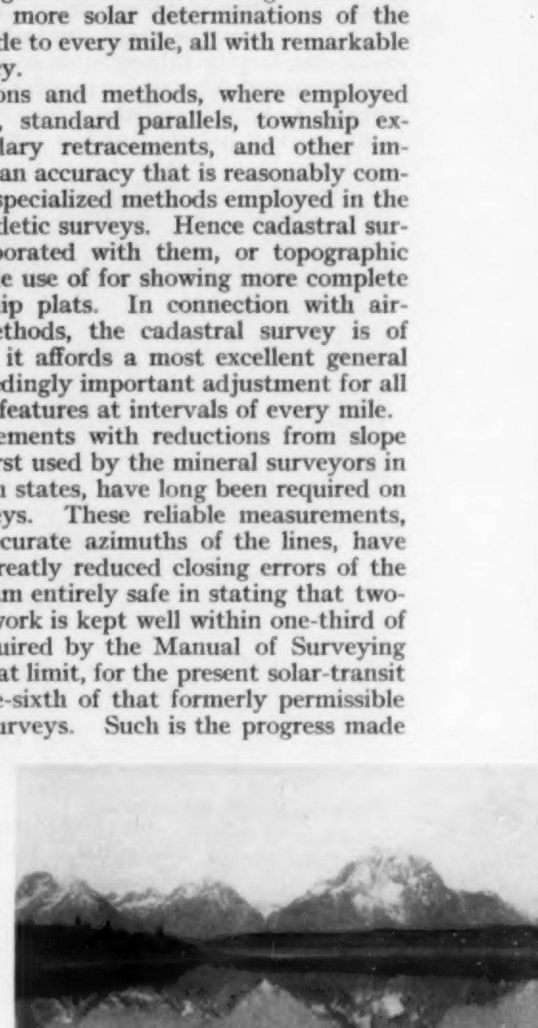
Of equal interest to engineers is the advance that has been made in the accuracy of cadastral surveys. Most of the very early public land surveying was done with the needle compass, generally with inadequate determinations of the magnetic declination.

The solar compass was introduced in 1836 by William A. Burt, who was engaged on General Land Office work in the state of Michigan. Here, in a region of great disturbances due to local attraction, the solar compass proved its true worth. However, it required nearly fifty years to bring it into general use.

By 1880, the need for surveys in Colorado and other Rocky Mountain states had become pressing, but here the use of the engineer's transit, rather than the compass, was required. Another United States surveyor, Benjamin H. Smith, designed the solar unit that bears his name, which afterward became the standard instrument on General Land Office surveys. In more recent years the accepted model has been the engineer's light mountain transit which has been perfected and properly equipped for making all needed observations on the sun and polaris for frequent and exact determinations of time, latitude, and azimuth. The solar unit is used mostly in running lines through timber and undergrowth. As many as twenty or more solar determinations of the meridian may be made to every mile, all with remarkable rapidity and accuracy.

Transit observations and methods, where employed on guide meridians, standard parallels, township exteriors, state boundary retracements, and other important lines, attain an accuracy that is reasonably commensurate with the specialized methods employed in the topographic and geodetic surveys. Hence cadastral surveys may be incorporated with them, or topographic surveys may be made use of for showing more complete data on the township plats. In connection with air-photo surveying methods, the cadastral survey is of great importance as it affords a most excellent general control, and an exceedingly important adjustment for all notable topographic features at intervals of every mile.

Steel-tape measurements with reductions from slope to true horizontal, first used by the mineral surveyors in the Rocky Mountain states, have long been required on all public land surveys. These reliable measurements, coupled with the accurate azimuths of the lines, have made possible the greatly reduced closing errors of the current surveys. I am entirely safe in stating that two-thirds of all current work is kept well within one-third of the closing limit required by the Manual of Surveying Instructions—and that limit, for the present solar-transit methods, is only one-sixth of that formerly permissible for needle-compass surveys. Such is the progress made since the use of the magnetic needle was prohibited by law nearly fifty years ago.



The Teton Range Mirrored in Jackson Lake, Wyoming
On West Boundary of Teton National Park, Created by Congress and Under Consideration for Survey by the General Land Office

Tennessee Valley Emergency Construction

New Units and Economical Expansion of Existing Units to Add 300,000 Kw

By T. B. Parker

Member American Society of Civil Engineers
Chief Engineer, Tennessee Valley Authority, Knoxville, Tenn.

The construction program of the Tennessee Valley Authority for 1941 and subsequent years, as outlined in the budget request submitted to Congress in December 1939, provided sufficient generating capacity to meet the estimated normal growth of electric load in the Tennessee Valley area.

Early in 1940 it became evident that the demand for power was increasing more rapidly than had been anticipated, largely as a result of the acceleration of industrial load for the production of materials essential to national defense. The Advisory Commission to the Council for National Defense gave this situation consideration, and recommended to the President that construction of additional generating facilities be immediately undertaken by the Authority.

On July 31, 1940, a bill authorizing additional funds for the Tennessee Valley Authority to provide additional power capacity was signed by the President. This program includes the Cherokee Dam on the Holston River, additional generating units at Wilson and Pickwick Landing dams, and a steam generating plant near Watts Bar Dam, together with necessary transmission lines and other related work. The total capacity provided will be approximately 300,000 kw. The total estimated cost is $65,800,000, of which $25,000,000 has been appropriated for the fiscal year 1941.

Figure 1, which shows the available system power and estimated power requirements of the Authority through 1944, illustrates the rapid increase in system peak demand due largely to acceleration of the industrial load. This increased demand for power is indicated during the early part of 1942, and the successive installations (both in the normal program and in the emergency program) which will be available at that time to take care of this demand are added.

The principal reasons for selecting the TVA as the agency to provide this power are these: (1) The Tennessee Valley is favorably located with respect to present and prospective industries requiring large amounts of power for national defense work. (2) The Authority has an existing engineering and construction organization able to undertake this work immediately and efficiently. (3) Additions to the present TVA power generating system can be made at an unusually low incremental cost.

The particular projects selected were chosen with a view to economy, speed of construction, ease of procurement, and their ultimate relationship to a desirable multiple-purpose development of the Valley. During the present emergency it is contemplated that the Cherokee Reservoir will be used mainly for power generation, with other uses incidental.

Development of the Tennessee River has now reached a point where water stored on the upper tributaries can be used over an average head of 320 ft at main-river projects. By 1942 the total main river head developed will be 370 ft, and by 1945 it will approximate 500 ft. The foundation has thus been laid for increasing economy in future developments on the tributary streams.

The Cherokee Dam, located on the Holston River about 30 miles above Knoxville, will impound water for use over the entire developed head on the main river, plus the head at the dam, which will be about 150 ft with reservoir full. The initial generating capacity will be 90,000 kw.

Above this site the drainage area is 3,428 sq miles. It has an average rainfall of about 46 in. The average annual flow is 4,800 cu ft per sec with a minimum annual recorded flow of 2,840 cu ft per sec. The total useful storage will be 1,400,000 acre-ft, or about 40% of the mean annual runoff. This storage used over the critical dry period will augment the low flow of the river by about 5,000 cu ft per sec. The reservoir will be filled during the spring runoff period, normally in about three months.

The Cherokee Project plus the necessary additional capacity downstream, if operated for power only, will increase the prime power output of the TVA system which will be in existence in 1942 by 120,000 continuous kw, and the 1945 system by 150,000 kw. A substantial amount of additional secondary and dump power will also be made available.

This dam, being of only moderate height and considerable length, is well adapted to rapid completion, since construction work can be carried on simultaneously over its whole extent. It is scheduled for closure in January 1942, and can then store water for use downstream, whether or not its own generating capacity is available. Unless unexpected procurement difficulties are encountered, it is hoped to start operation of the first generating unit in the late spring of that year. Turbines and generators are all of standard type, and

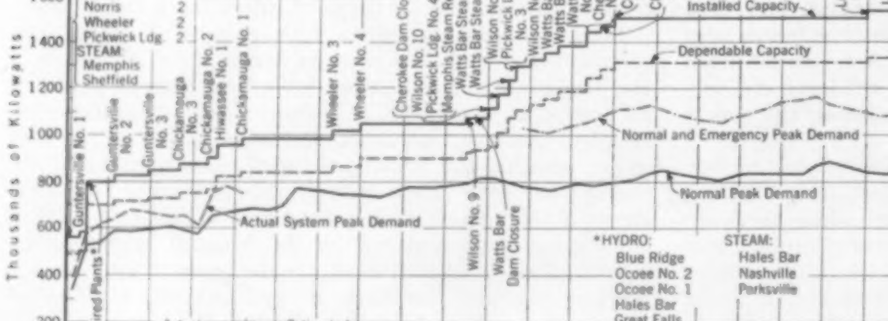


Fig. 1. Available Capacity and Estimated Peak Demand
Sharp Rise in Actual Demand Already Evident

will require little development work on the part of the manufacturers.

Installation of additional capacity in the main-river plants at Wilson and Pickwick Landing is necessary both to utilize the additional water supply made available by Cherokee Reservoir, and to provide the required system peak capacity. Since additions to the original generating capacities of these plants to utilize the present storage were already under way, further increases in capacity were greatly facilitated by duplicating units already on order. No important changes in plans or specifications were necessary in order to purchase the additional units, and the work of installing them will be carried on with crews already organized. Speed and economy will thus be realized to the fullest extent possible.

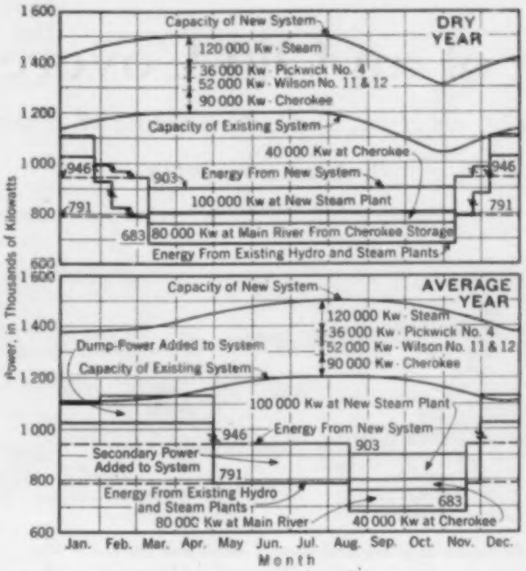


FIG. 2. SEASONAL DISTRIBUTION OF NEW POWER

The Wilson and Pickwick Landing units included in the present emergency program are the fourth 36,000-kw unit at Pickwick, and Wilson units Nos. 11 and 12, of 26,000-kw capacity each. These are scheduled to go into operation in March and April 1942.

To prime the large amounts of secondary power available on the TVA system after the addition of Cherokee and the units downstream, an additional source of dependable energy was necessary. It was decided that in view of all the circumstances, a new steam plant of the proper characteristics would do this to the best advantage. Such a station can be built in a short enough time to meet the estimated load requirements.

The new steam station will have a generating capacity of 120,000 kw and will be located about 3,500 ft downstream from the Watts Bar Dam. This location has the advantages of (1) relatively inexpensive fuel (local coal), (2) direct transmission connection (using Watts Bar hydro switchyard), (3) gravity supply for condensing water, (4) favorable site already owned by the Authority, (5) existing rail and highway connections, and (6) existing organization and plant available for construction.

This last item is of considerable importance. The organization now building Watts Bar Dam, together with complete camp, plant, and storage facilities, will be available for the concurrent construction of the steam plant. This will make possible large administrative savings, and has allowed immediate starting of construction operations.

Figure 2, showing the duration and amount of power from the proposed new projects, indicates how this additional energy will prime the available secondary power of the system during a dry year and during an average year. This figure also indicates how energy from the steam plant primes the available hydro energy, adding 100,000 kw of continuous power to the system. Together, the Cherokee Project, the downstream units, and the steam plant will add a total of about 220,000 kw of continuous power in 1942.

The day after the authorization, construction forces were at work building an access railroad to the Cherokee Dam, and purchase of the necessary materials was begun immediately. Figure 3 shows the status of construction of the Cherokee Project on November 28, 1940, 17 weeks after the work was authorized by Congress. It has been recognized from the beginning that manufactured equipment would be most difficult to secure under present conditions. With this in view the bill provides that much of the usual Government purchase procedure can be dispensed with where necessary. By September 1, contracts had been awarded for three 30,000-kw hydraulic turbines and generators for the Cherokee Dam, for two 26,000-kw turbines and generators for the Wilson Dam, one 36,000-kw turbine and generator for Pickwick Landing, and two 60,000-kw turbo-generators with two 600,000-lb per hr boilers for the steam plant. The total purchases for the emergency program amounted at that time to more than $10,000,000.

The incremental cost of additional prime energy supplied by the emergency program will be about 1.5 mils per kw hr at the switchboard. This assumes the entire cost charged to power and includes interest on the invested capital at 3%, together with appropriate allowances for depreciation, operation, and maintenance.

General responsibility for this work rests primarily with the writer. The responsibility for planning, design; and construction is the province of S. M. Woodward, chief water control planning engineer, H. A. Hageman, chief design engineer, and A. L. Pauls, chief construction engineer. Lee G. Warren is project manager of the Cherokee Project, and F. C. Schlemmer holds the same position on the Watts Bar Project.

FIG. 3. CHEROKEE PROJECT ON NOVEMBER 28—17 WEEKS AFTER BILL WAS SIGNED

Log Crib Cofferdams on Each Bank Have Been Completed and River Diverted Between them; Construction Plant Buildings Are at Left Center; Upstream and Downstream Bridges Are Temporary

Anatomy of an Old Covered Bridge

A Truss, an Arch, and a Sprinkling of Anecdotes

By Irving A. Jelly
Palmerton, Pa.

EARLY nineteenth century textbooks on civil engineering suggest that engineers had "bridge-itus" or a desire to exploit the new types they might invent. As late as 1882 there appeared in Trautwine's *Handbook for Civil Engineers*, under "trusses," descriptions of Town's lattice bow-string, and of the Moseley, Bellman, Fink, Pratt, Howe, and Burr designs. Forces are referred to as "chasing each other around," tension is "pull," and compression is "push." After a lot of experimentation it seems that the engineers settled for a good long while on the Burr type, a combination of Howe truss and arch. That their choice was a good one is evidenced by the fact that bridges of this construction have outlasted most of the others. Covering them probably helped, but the secret lies in the arch, which the ancients found by trial and error held heavy loads with all parts in compression. Tension as we know it could not be taken by anything in the structural line then manufactured.

Etching by Author

An hundred years and more I ween this covered bridge
Has spanned the stream; its mortised beams of sturdy oak
Have stood the strain of countless folk on errand bent
To mill or town, to school or church the country round.
—*Anonymous*

Of course iron was in use in 1880. The charcoal iron furnaces of Harrity and Little Gap, Pa., which forged long links of $1^1/_2$-in. square puddled charcoal iron for the chain bridge over the Lehigh River at Lehigh Gap in 1825, indicate that iron was winning respect for use in "pull." Suspension types of bridges were being designed at about the same time that the Burr bridges were under construction in and around Pennsylvania.

Collecting data on these old Pennsylvania bridges is a hobby with me. Very little iron was used in the covered bridge—only coarse threaded bolts with large square heads and nuts and some square spikes. Sometimes the threads were omitted, and wedges were inserted through slots in the bolt ends. Possibly this procedure was followed because iron was scarce and good wood of large proportions was easy to obtain locally. I believe they used well-seasoned timber, for very few shakes and shrinkage gaps are to be found in any of the bridges.

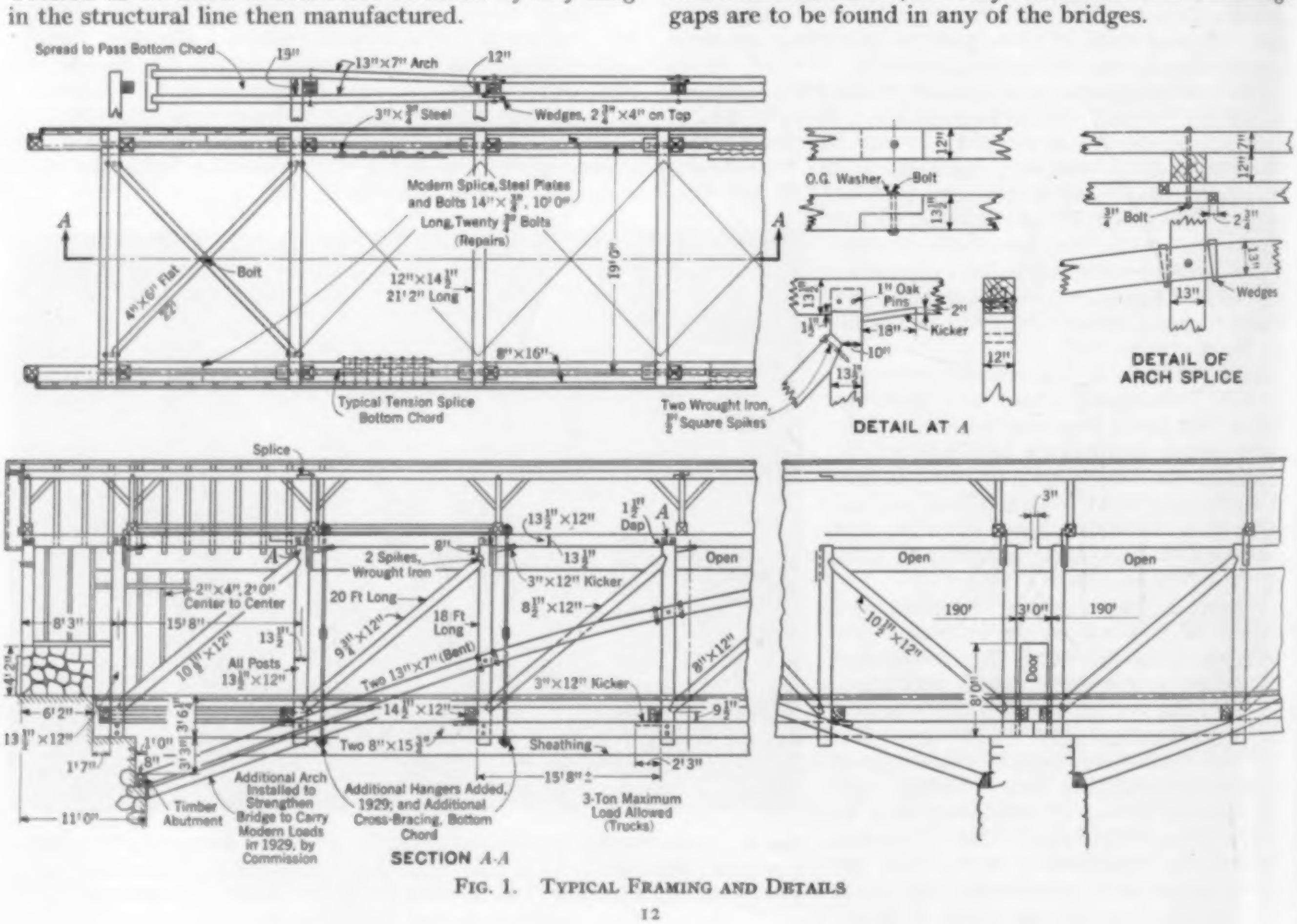


Fig. 1. Typical Framing and Details

Some of the smaller bridges are of oak, hand hewn with mortise and tenon joints and rock oak pins connecting them. Broad ax, adze, crosscut saw, chisel, and mallet were the common tools. Larger bridges are generally of white pine. This wood is rather soft and free of knots or shakes, but has a fairly high tensile value. The extreme lengths and immense cross sections demanded were easily obtained from the large virgin forests of the time.

Bridges of the Burr type were much used for railroad work, some with three sets of arches on each side. Long iron suspender bars were employed. That the inherent objections to the Burr design were nevertheless recognized is evidenced by two revealing comments from Trautwine, (1) "many early ones failed under railroad traffic," and (2) "a truss and an arch cannot be so combined as to act entirely in concert. . . . " But he adds, ". . . yet as any ordinary truss begins to fail, the almost invariable remedy is to add an arch!" A great number of these bridges are still extant in Pennsylvania, Indiana, and New England.

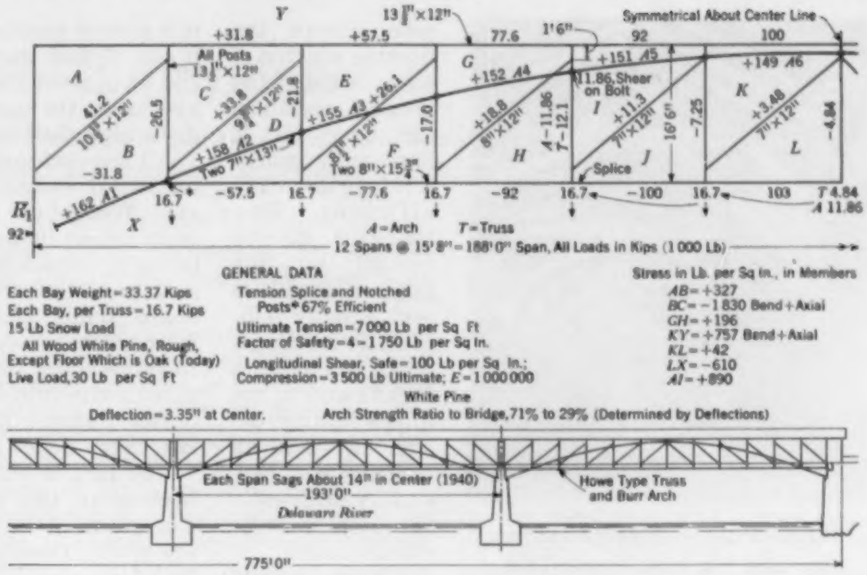
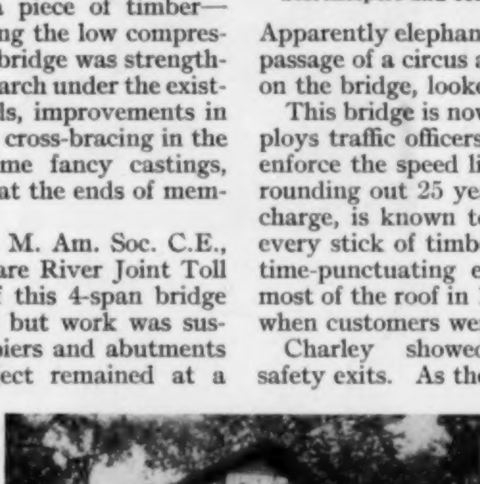


FIG. 2. LOADING AND FORCES

Present engineers, in repairing the Burr bridges, do add additional arches and steel suspender rods, binding top chord to bottom chord, and hanging rods from tops of arches to bottom chords for roadway suspension. One bridge at Little Gap, Pa., was recently repaired by sawing off and replacing 3 ft of the arches at the abutment and splicing the parts together with steel plates and many bolts.

This Portland, Pa.–Columbia, N.J., bridge over the Delaware (near the Delaware Water Gap) is a delightful example of Burr construction. The arch reaction is carried against the side grain of a piece of timber—which is very bad practice considering the low compressive strength in this direction. The bridge was strengthened in 1929 by adding an additional arch under the existing ones. Extra steel suspender rods, improvements in the floor system, and supplementary cross-bracing in the lower chord were introduced. Some fancy castings, shown also in Trautwine, were used at the ends of members.

According to Louis Focht, Assoc. M. Am. Soc. C.E., chief engineer of the present Delaware River Joint Toll Bridge Commission, construction of this 4-span bridge of 775-ft length was begun in 1839 but work was suspended for lack of funds after the piers and abutments were nearly completed. The project remained at a standstill until 1868 when construction was resumed, and the structure was finished during the following year, 1869. The entire cost was about $46,600. Charles Kellogg, later of the firm of Kellogg and Maurice, Athens, Pa., which was subsequently incorporated as the Union Bridge Company, was the designer and constructor. The record states that the Columbia Delaware Bridge Company was created by act of the New Jersey legislature dated March 7, 1839, but the date when similar legislation was passed in Pennsylvania is not available. Title to the bridge was not acquired by the Commonwealth of Pennsylvania and the State of New Jersey until May 2, 1927.



ONCE KNOWN AS COLUMBIA DELAWARE BRIDGE
Load Limit, 15 Cattle or 25 Sheep (No Elephants)

The carefully graduated system of tolls prescribed to repay the construction and maintenance charges is worth repeating:

Sheep and swine	$0.02 each one way
Cattle	0.03 each one way
Horse and rider	0.10 each one way
Each extra horse led	0.06 each one way
Single rig	0.15 each one way 0.25 each round trip
Team	0.20 each one way 0.40 each round trip
Man, wife, and family	0.50 per month
Storekeepers and coal men	0.20 each round trip

Apparently elephant rates were not posted, for during the passage of a circus at one time, the elephant put one foot on the bridge, looked up, backed off and swam the river.

This bridge is now free, and the Joint Commission employs traffic officers in two shifts to maintain order and enforce the speed limit. Charles J. Newbaker, Sr., now rounding out 25 years of continuous service as officer in charge, is known to everybody as Charley. He knows every stick of timber in the bridge and remembers such time-punctuating events as the cyclone that tore off most of the roof in 1929, or the dull winter of 1917–1918, when customers were able to use the ice all season.

Charley showed me a charming wrinkle in safety exits. As the roadway is only 17 ft 9 in. wide, a pedestrian caught on the bridge with carriages hastening toward him from both ends might begin to wonder about the future. But in the narrow space between spans at the piers the builders thoughtfully provided escape doors opening out over the water. Presumably, the otherwise trapped pedestrian is entitled to step through these into the relative safety of the river only a few feet below. Also, this is where Charley hides to catch his speedsters.

The old bridge is made of white

TRANSPORTING OF FIRE RESTRICTED
Roadway Sag Adds "Swoops" for Motor Vehicles

pine, except the flooring which is of oak. Some of the tension members are over 65 ft long with splices 8 ft long and 67% efficient. The halved posts crossed by the tension members are equally efficient. As engineers will note in Figs. 1 and 2, the forces in this design are not all concurrent. Secondary stresses in the posts must be considerable.

For its general interest, I have endeavored to obtain the relative stiffnesses or deflections of the Howe truss and the arch. Taking the bridge as shown in the figures and as originally constructed, with the dead weight of the bridge and housing, a 15-lb snow load and a 30-lb live load, the panel load adds up to about 33,370 lb. Both arch and truss appear to be heavily overloaded when this amount alone is used for either.

Now the truss and arch will share the total load in proportion to their respective stiffnesses or deflections and both will deflect identically as they are bolted together at all posts. This fact permits the analysis indicated in Fig. 2 which shows that the arch should carry 71%, and the truss take 29% of the load. The deflection of the two together should be about $3^1/_3$ in. at the center of the span. Actually a sag of 14 in. has accumulated through the years in all four spans. It is comfortingly concealed by the clapboard siding which must have been recently renewed, but a trip over the bridge at 30 miles an hour would probably be rather thrilling.

Perhaps the sag is partly responsible for the introduction of a ten-mile speed limit several years ago. With the number of cars a year approaching 500,000, it probably became difficult to ignore them altogether. However, the familiar notices for animal traffic have not been removed, and if you should cross on a wintry night with a horse and buggy you might still be called upon to pay "$10 Fine for Riding or Driving Across This Bridge Faster Than a Walk" (4 miles an hour) or "$10 Fine for Smoking or Carrying Fire Across This Bridge, Unless Fully Secured in a Lantern or Other Vessel." The danger of dynamic loading was evidently recognized.

Both static and dynamic live loads must have been considered in establishing the prescribed limit of 15 cattle or 25 sheep or swine permitted on a span at one time. It has now been reinforced to carry a modern truck load of 3 tons.

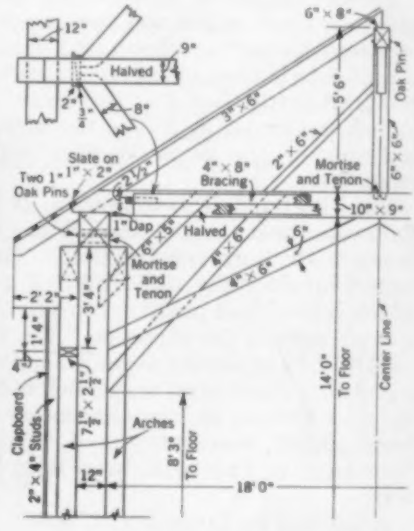
Each of the four spans is 190 ft long. To the best of my knowledge this makes it the longest covered bridge in the country today. The massive abutments seem to have been designed for arch thrust, as they are wider than the bridge and made of native limestone set in lime mortar. The center piers are quite narrow, and it is a moot question whether all the spans would collapse if one should wash out. However, in 1903 a flood did rise 16 in. over the floor, drove a tree through the siding, and broke the upstream bottom chord without seriously disturbing the rest of the structure.

All the arch joints are ship-lapped and provided with hardwood wedges which are driven home to reduce the sag. Wedges are also used to take up slack at ends of all cross braces in the top and bottom chords. They were probably struck frequently as shrinkage occurred. The structural timbers are never painted, though the clapboard siding and portals are usually painted white. Authorities agree that the chief idea of the housing was to protect the main timbers from rain and snow. Although the bridge has probably held crowds of people during a storm, the members have been carved or mutilated very little.

The roof is vulnerable to the attack of wind, largely because of the ventilation provided under the eaves. The storm of 1929 tore off most of the siding as well as the roof. Details of the roof framing are indicated in Fig. 3.

The bridge flooring formerly had a life of only 5 years, but nowadays it lasts much longer under rubber tires. It was built in two layers, the lower of 3 by 10-in. yellow pine and the upper of 2 by 10-in. white oak. Joists supporting the floor were at first 2 ft apart but the spacing was later changed to 16 in. The knee braces on the flanks are sheathed over arch feet and make the bridge look very strong and rigid—as indeed it is.

FIG. 3. ROOF AND TRUSS BRACING



In an article in the *Highway Magazine* for October 1938, R. B. Yule said that prior to about 1847, when Squire Whipple published his treatise, rule-of-thumb and experience were the principal guides for determining the sizes of members. Scale models were known to have been constructed, and bridge strengths determined by multiplying the failure load of the model by its linear scale. Subsequent full-scale behavior must have added appreciably to the store of practical experience, particularly of what not to do. Mr. Yule assumes that the first members to fail were strengthened until the bridges were secure. If this is true, the "theory of limit design" may be older than we had supposed.

Oh! noiseless age, with sober comforts blessed—how changed
Thou art. Now, every clanging, speeding thing disturbs our
Rest. Through storms and floods, Oh, living bridge, may you
Endure to mark an age when homely ways were so secure.

—Anonymous

Role of the Engineers in Warfare

Technical Corps of the Army Becomes a Corps d'Élite as Mechanized Fighting Demands Increased Participation in Assault Operations

By Julian L. Schley

Member American Society of Civil Engineers
Major-General, Chief of Engineers, U.S. Army, Washington, D.C.

Civilian engineers and construction men of peace years become military engineers in war years. Time replaces cost as the dominant concern. To construction training must be added familiarity with the weapons and equipment of the cooperating arms and a knowledge of combat tactics for personal use. General Schley presents here the modern concept of military engineer functions and outlines the varied activities of engineer units. Subsequent articles are planned to deal separately with current practice in road work, stream crossing, and construction activities of engineer troops in time of war.

Fortunate are the branches of the army defense forces whose functions correspond to peaceful pursuits! Among these is the Corps of Engineers. Recourse to engineering in waging war goes back to the beginning of wars, both in defensive tactics and in offensive. The castle of the baron of old and the fort of today represent engineering in defense. In offense, the battering ram brought up to breach the castle wall has its modern corollary in the assault forces with high explosives and flame throwers approaching a fort under cover of bombs, smoke screens, and gun-fire. And always there have been available engineers and artisans as a source of military engineers. Today in particular the engineering construction forces provide such a source.

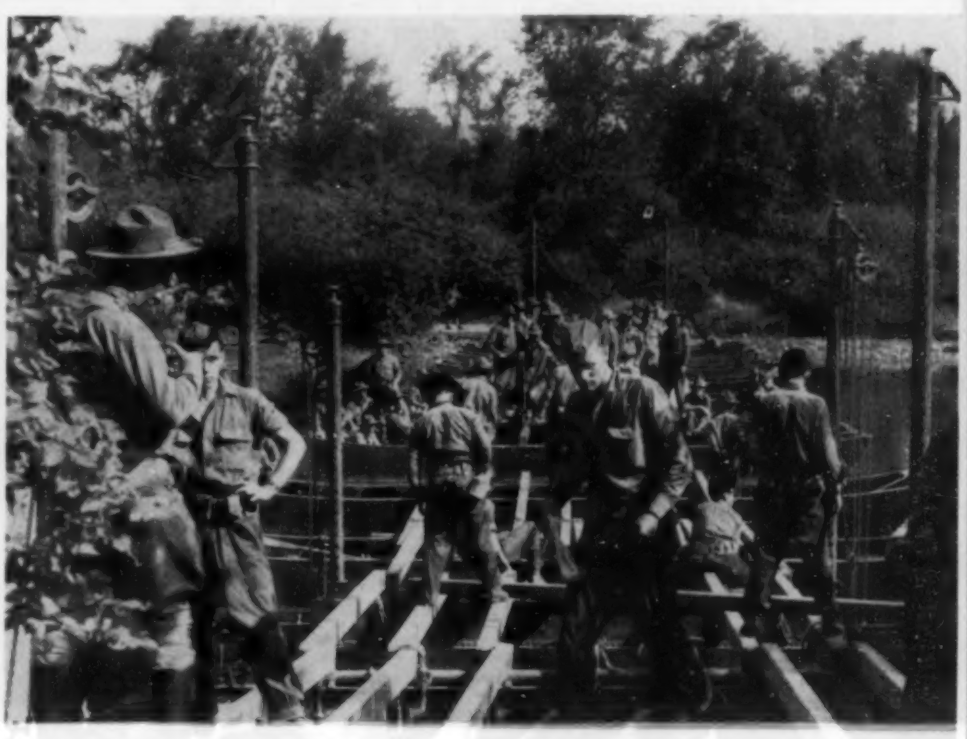
As in all undertakings, successful leaders in war require long training and experience. The provision of commissioned officers and non-commissioned officers for the army is a difficult problem, but this problem is immeasurably simplified if men can be obtained for a new regiment whose civilian experience has partly developed and trained them. An advantageous composition of such new military engineer units is achieved if they can be formed with construction engineers as officers, foremen as sergeants and corporals, and men who are used to working with their hands as soldiers.

The functions of military engineers, expressed in the simplest terms, are to aid the movement of troops, to impede the movement of the enemy, to take part in combat, and to build structures for the shelter and protection of personnel and for the storage and transportation of supplies. Among the aids to the movement of troops may be included removal of obstacles, reduction of fortified places, strengthening of bridges, repair of highways, and ferrying of streams. Movement of the enemy is impeded by such means as destruction of bridges, laying of land mines, construction of fortifications. These things are accomplished in general with common hand tools, with some special equipment, and with construction materials. The conditions under which they are done vary from combat conditions in the presence of the enemy to more normal conditions in rear areas little affected by hostilities.

Let us consider first the operating conditions at the front. It is a simple thing to describe the method of construction or demolition of a bridge, the neutralization of a fort, or the construction of a tank trap, but in the forward areas of war the conditions under which these things are done introduce immeasurable complications. Perhaps the job must be done in the face of the enemy, where a mistake in judgment will be paid for with the lives of men; perhaps it must be done in the dark, cold, rain; perhaps with men who have spent sleepless nights and days on end. Probably the circumstances will be such that failure would mean disaster. Failure is unthinkable.

Already we have many accounts from Europe attesting to the value of the work of the modern engineer in war time. The lightning-like thrusts of the German Panzer divisions in Poland depended directly on the engineers who kept the routes of advance free of obstacles. And when those same divisions were locked in a life-and-death struggle with a trapped and desperate enemy the engineers took their place in line alongside the infantry in the successful combat that ensued.

Skill of an engineering nature has become so important in modern warfare that the relative numerical strength of the engineers is greater than formerly. On the other hand, the tendency toward smaller, faster moving, harder hitting divisions requires that the number of men who do



Fifth Engineers Construct $7^1/_2$-Ton Ponton Bridge

In Combat, Speed Would Measure Success of Crossing and Control Extent of Casualties. Only Rehearsals—Such as This at Plattsburg, 1939—Excellence of Equipment, and Excellence of General Training Can Assure Speed Under Fire *Photo by U.S. Army Signal Corps*

Photo by U.S. Army Signal Corps

AMERICAN ENGINEERS REPLACE BRIDGE BLOWN UP BY RETREATING GERMANS—DUN SUR MEUSE, FRANCE, NOVEMBER 1918

Greater Speed of Present-Day Movements Demands Prefabricated Bridge Elements for Advanced Crossings

not take part in the tactics of "fire and movement" be kept to a minimum, with the result that now, more than ever, engineers are "combat" troops. The tactics developed by the Germans in attacking fortifications with a team in which engineers (whom they call "pioneers") form the assault spearhead, have made the engineers a combat arm d'élite.

In France and the Low Countries, the problems of the invader were different. Here there were fortified lines to be breached and numerous strongly held rivers and canals to be crossed. The engineer with his explosives, assault boats, ferries, and bridges was the very key to success. Unfortunately, the opportunity to observe engineer operations in the defense was lost. Had not the French given way on one flank and the Belgians on the other, we might have seen demonstrated the effectiveness of the tank traps and other defensive works with which British engineers had covered their entire front and which they were forced to abandon because of the reverses to their allies on the flanks. Also, had the long-heralded German invasion of England been attempted, it would probably have afforded another convincing demonstration of engineer might in coastal defense.

The engineers referred to thus far have been those of the so-called "combat" units, which work intimately with the infantry and artillery of the division and corps as part of the combat team. While these combat units are helping the infantry and the artillery to cross streams and to break through defensive lines, other engineers are working farther to the rear. There they are keeping open routes of communication, constructing or repairing airfields, insuring the supply of maps, providing for camouflage, and performing innumerable miscellaneous technical tasks. Some idea of the several kinds of units of engineers in our army may be gained from Table I.

A new kind of engineer unit being created in the present mobilization is of particular interest, namely, regiments for service with the General Headquarters Air Force. Their principal duties are the construction, maintenance, and repair of airdromes and their ground defense structures. The importance of the functions of air engineers becomes obvious when it is considered that air fleets are just as dependent on adequate bases as are navies. The engineering problems arising in the development of an air field are of the most fascinating kind: drainage, stabilization of soils, concealment, camouflage, defense, communications. In an engineer regiment (aviation), the officer finds problems worthy of his metal.

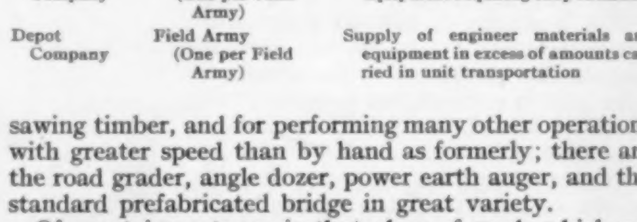
The increase in the army's use of motor vehicles for transportation (motorization) and of mechanical devices for combat (mechanization) has resulted in an increase in the range and complexity of equipment for the engineer arm. For example, there is the air compressor for drilling holes in concrete to prepare for demolition, for

TABLE 1. ENGINEER UNITS AND THEIR DUTIES IN THE U.S. ARMY

Kind of Engineer Unit	Larger Army Unit of Which It Is a Part	Type of Missions Normally Performed
Combat Battalion	Infantry Division (One per Division)	General "combat" engineering: bridging, demolitions, creation of obstacles, infantry combat
Combat Regiment	Army Corps (Two per Corps)	General combat engineering, similar in nature to those enumerated under (1) with more emphasis on work somewhat farther removed from combat; water supply, road maintenance
Topographic Company	Army Corps (One per Corps)	Development, reproduction, and supply of maps, overlays, etc., to the various tactical units
General Service Regiment	Field Army (Three per Field Army)	More substantial military engineering tasks, particularly rear-area construction including railways, utilities, road and building construction
Light Ponton Company	Field Army (Four per Field Army)	Transporting and maintaining the "light" (10-ton) ponton and trestle bridge equipage and aiding in bridge construction when necessary
Heavy Ponton Battalion	Field Army (Two per Field Army)	Same as light ponton company except equipment is suitable for loads of 25 tons
Topographic Battalion	Field Army (One per Field Army)	Map-making, especially from aerial photographs by multiplex method, reproduction and supply of maps
Separate Battalion	Field Army (Six per Field Army)	General engineer construction, reinforcing general service regiment or corps combat regiment
Camouflage Battalion	Field Army (One per Field Army)	Manufacture and supply of camouflage materials and supplies, including supervision of training in camouflage measures
Water Supply Battalion	Field Army (One per Field Army)	Purification and transportation of water
Dump-Truck Company	Field Army (Two per Field Army)	Provides transportation for engineer tasks requiring rock, gravel, earth, etc.
Shop Company	Field Army (One per Field Army)	Repair and maintenance of engineer equipment requiring shop facilities
Depot Company	Field Army (One per Field Army)	Supply of engineer materials and equipment in excess of amounts carried in unit transportation

sawing timber, and for performing many other operations with greater speed than by hand as formerly; there are the road grader, angle dozer, power earth auger, and the standard prefabricated bridge in great variety.

Of great importance is that class of work which resembles peace-time engineering construction more than



WATER FOR DRINKING AND COOKING

Pump Truck (Left) Delivers 100 Gpm, Filtered, Purified, to Canvas Tank—an Engineer Function

New Type of Anti-Tank Obstacle Under Test
Such Devices Would be Supplied by Engineer Depots and Erected by Defending Troops Under Engineer Supervision

any other. This is temporary and semi-permanent construction in the rear territory, such as cantonments for training areas, rest areas, etc.; hospitals; seaports and port facilities; railroads; depots for storage of supplies and materials. These facilities were built in great numbers by the Corps of Engineers in France in the last war. In some instances the work is done by troops, but more often by civilian labor and sometimes by construction firms under direction of the Engineers.

In such a brief treatment of a broad subject, there is danger lest undue conclusions be drawn from omissions. In any discussion of the Engineers in the army in war, it is therefore important to draw attention to the fact that engineers are also included among the specialists of the Quartermaster Corps, the Ordnance Department, and the Signal Corps. Nor is the war effort of engineers confined to men in uniform. There are designing and construction engineers building cantonments and air fields in the home areas, and developing and manufacturing ordnance and signal equipment, aircraft, and motor vehicles.

Men in an engineering construction force are familiar with the principles of army organization. On a construction job, there is the responsible head, the construction superintendent, whose knowledge and experience make him the natural, respected leader to whom all look for direction; there are the foreman, also experienced men, who supervise and direct the work of the several groups of workmen into which the force is subdivided for better control and direction; and finally there are the workmen themselves with their tools and power machines, among whom are straw-bosses for more intimate leadership. The same relationship exists among the battalion commander, his subordinate officers, and the sergeants, corporals, and soldiers. In the construction organization, as in the army unit, there is a direct line of control (or command) from the head through the subheads to the workmen, and there is the line of responsibility running in the opposite direction from the workmen up. Both construction force and army work "in the field" so to speak—out of doors in spite of conditions, away from the improvements of civilization which make for simple and comfortable living. There are the same problems of housing and feeding the men, of sanitation, and of the creation and maintenance of that high morale which is so necessary for the best results.

This comparison has been made with the army as a whole, that is, with all combat branches of the army. The similarity is of course closer in the case of the engineering construction force and the engineer battalion or regiment, in that the purpose in large part in both cases is to build a structure (or destroy it) with hand and power tools and explosives. Both are dealing with natural laws. Construction work in time of peace, for these reasons, trains men for the army and in particular for the engineer branch of the army. If in fact a new engineer regiment is composed of personnel as already described, that is, construction engineers as officers, foremen as non-commissioned officers, and men who are skilled at manual work as soldiers, then indeed you have an engineer regiment in the making at the outset. The men will soon realize that every bit of experience they have had in constructing highways, railroads, bridges, wharves, and buildings is useful; that their understanding of organization, of responsibility, of loyalty will stand them in good stead.

After noting the similarity of these peace and war activities, we should pause to mention the differences, lest the conclusion be jumped to that a construction force becomes a military unit merely by donning uniforms. There is an enemy to be dealt with in war, and he produces conditions as troublesome as the most adverse laws of nature. These conditions greatly affect the operations of the engineer battalion and regiment in war, and therefore greatly affect their training. Not only are the principles that guide the work of these units affected by the conditions created by the enemy, but the units themselves must take their places in the combat team as fighting forces, and to do this, skill in the use of arms must be learned by the men, and the specialized teamwork of tactics must be familiar to the leaders.

In the development of the military engineer there is involved what the layman might term a dual function—the technical on the one hand, and the tactical or combat on the other. These are not distinct, because many military engineer missions involve both technical and tactical elements. The emergency conditions that occur in infinite variety in war call for a kind of resourcefulness which is developed by military training. Proper teamwork with the other combat branches requires an appreciation of their tactics also. There is no royal road to mastery of the principles of tactics and of the technique of a branch of the service, and any man receiving a commission in time of emergency must look ahead to hours of intensive application during his time in the army. In fact, a regular officer of the army, like a civil engineer or any other professional man in time of peace, can keep abreast of his profession only through never-ending study and practice. An officer of Engineers must have the technical ability and the spiritual force to overcome the most challenging obstacles.

In military operations, the element of time instead of cost assumes prime importance, bare necessities must suffice; usually there is a shortage of the right materials and makeshifts have to be resorted to; factors of safety are reduced to a minimum; labor is usually plentiful; plant is often not where needed. Finally, and most important, engineer units must be ready to come to grips with the enemy in combat as infantry or as assault engineers. The engineer is perhaps the most versatile of soldiers. There is no branch of the army in which ingenuity plays so important a role. He must have much of the basic knowledge of the infantryman and, in addition, must have mastery over the multitudinous special and technical tasks that will come his way. He must have self-reliance in high degree, for frequently he must be working far from direct supervision. It is not to

Railroad Bridge Mined by Germans in 1914
An Incomplete Demolition That Might Permit Re-Use with Temporary Trestle Work

be wondered at that the differences even for engineers between civil pursuits and military service loom large to the man entering the army.

In nations that maintain large armies in peace time, there is ample time to train the officers and the men individually and as teams. Not so in a nation that increases its army forty-fold on the outbreak of war, as we did in 1917, when the strength grew from 108,000 to 4,000,000 officers and men. The increase in Engineer strength was even greater than the average—from 2,400 officers and men to about 308,000 at the end of the war. Our allies kept the enemy busy while we mobilized, equipped, and partially trained this large army. Fortunate then, I say, are the branches in our army which can draw from civil pursuits men who are already partly trained.

CONSTRUCTION BY NEW 21ST ENGINEER REGIMENT (AVIATION)
Tractor Crane Placing Truss for Motor Transportation Shop—Langley Field, Va.

SOURCES OF ENGINEER OFFICERS

Reference has been made to the difficulty of obtaining leaders. Let us look at the expansion in officer strength. The Engineer commissioned officer strength was 277 at the beginning of the World War and 10,700 at the end. We got our additional officers by putting selected professional engineers of good character and standing in their communities through a three months' intensive course at officer training camps. We have an even better method of obtaining additional officers in the present mobilization—better for all branches of the service. One of the very wise provisions of the national defense law amended after the World War was the creation of an officers reserve corps. The source of young men to feed into this corps is the so-called Reserve Officers Training Corps units established at many of the colleges and universities in the country, where officers of the Regular Army give instruction in military subjects. For the engineers, these units are established at engineering colleges. It is not practicable to establish R.O.T.C. units at all engineering colleges, though many additional colleges desire them. Those already established provide the number of reserve officers set up as the requirement. R.O.T.C units of other branches of the service are also located at engineering colleges, with the result that many engineers will be found among the reserve officers of these other branches. At the beginning of this emergency the strength of the Officers Reserve Corps for all branches was about 120,000, of which about 8,000 were engineers. Another part of our army that brings to us many fine engineer officers is the National Guard. Many of these Guard officers are practicing engineers up to the time they are mobilized and most of them have had the further advantage of regular summer training with large army units.

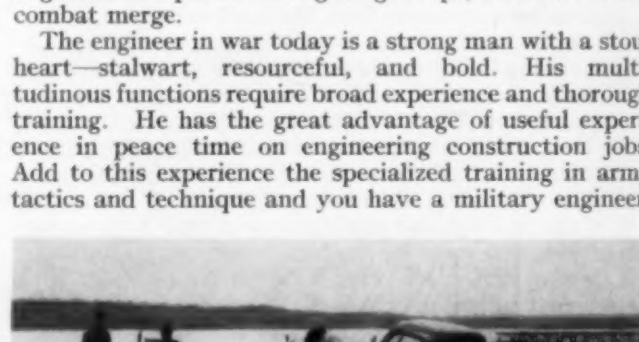
The research and development agencies of the Corps of Engineers deserve a word. At Fort Belvoir, Va., is located the Engineer School where class after class of regular, reserve, and National Guard officers are being "refreshed" on the latest developments in Engineer tactics and technique. Working with the Engineer School are special committees of officers charged with investigating every promising "lead" coming from Europe or elsewhere. Then there is the Engineer Board, also at Fort Belvoir, devoting all its extensive facilities to research in the development of new items of equipment. A newcomer joining the ranks of the Engineers may do so with the assurance that no effort is being spared to discover, to teach, and to apply the most advanced doctrines and methods.

Photo by U.S. Army Signal Corps

PIER AND TRESTLE BY U.S. ENGINEERS, FRANCE, 1919
In Aggressive Phases of Defense, Ship-to-Shore Terminal Facilities Assume Critical Importance

In conclusion, the work of engineers in war might, in the interest of clarity, be enumerated by classes. There is the work, principally construction in nature, performed by civilians under supervision of the Engineers behind the areas occupied by the army, in contradistinction to the work farther to the front done principally by troops. Then there is the work in the areas occupied by the rear echelons of the army where, though the work is done by troops, it may or may not be under enemy fire, in contradistinction to work at the front itself where there is contact with the enemy. And last, there is the work of the engineers as a part of the fighting troops, where work and combat merge.

The engineer in war today is a strong man with a stout heart—stalwart, resourceful, and bold. His multitudinous functions require broad experience and thorough training. He has the great advantage of useful experience in peace time on engineering construction jobs. Add to this experience the specialized training in army tactics and technique and you have a military engineer.



PORTABLE STEEL TRACKS SIMPLIFY FERRYING IN ATTACK
Rafts Built on Assault Boats Provide Important Supplement to Bridging During a Rapid Advance

Concrete Mixing and Placing on Large Dams II. Performance and Prices

Actual Operating Rates and Unit Costs of Specific Projects Compared

By ADOLPH J. ACKERMAN, M. AM. SOC. C.E.

DIRECTOR OF ENGINEERING, DRAVO CORPORATION, PITTSBURGH, PA.

IN plain, direct language, this paper evaluates and explains the relative effectiveness of the handling methods and organizations used on selected big dams of recent years. Unit costs have been carefully adjusted to a comparable basis, and the problem of unbalanced bidding is frankly presented in the light of the contractor's need for early assistance in financing. This is the sequel to Mr. Ackerman's previous article comparing equipment and procedures in general.

VERY little comparative information has been developed in the past regarding construction methods, progress rates, and costs of major dam projects. It has been generally felt that local conditions were unique for each site and of such controlling importance as to preclude making any practical or useful comparisons between projects. Although the importance of these factors is granted, the writer has found that certain comparisons are feasible and provide valuable information of a broad and basic nature.

An interesting representation of such data is obtained by plotting cumulative (or mass) curves of concrete placing progress for similar dams, as shown in Fig. 2. The curves are segregated into two classes, one for canyon-type dams similar to Norris, the other for wide river dams similar to Conowingo. The slopes of the curves represent rates of concrete placement, or in other words, capacity and performance of the construction plant.

A single day's record of performance is usually not very important. It is the average continuous performance that counts. This is clearly demonstrated by these curves. The maximum rate of placing, or best ability of the plant, is represented by the steepest part of the curve. To whatever extent the curve has flatter slopes during other periods, the available plant capacity has not been fully utilized. Of course this generally means that other factors such as river handling, weather conditions, or specification limitations on rate of placing have a controlling influence, but all things being equal, the most efficient project maintains its maximum output as continuously as possible.

A study of Fig. 2(*a*) for canyon-type dams, discloses some very interesting facts. For discussion purposes, the curves may be grouped into several natural subdivisions.

The curves for Hoover Dam, and for Grand Coulee Dam, Contracts Nos. 1 and 2, are in a class by themselves. Each of these projects had from three to five million cubic yards of concrete and the rate of placement was around 200,000 to 300,000 cu yd per month. It is interesting to note that the average capacities of all three plants were very similar. It is doubtful if greater placing rates will ever be attained or justified.

The next group of dams, averaging about 1,000,000 cu yd, includes

Norris—1,000,000 cu yd, placed with two 6-yd cableways
Tygart—1,250,000 cu yd, placed with four 3-yd whirlers
Marshall Ford—1,100,000 cu yd placed with one 8-yd cableway
Hiwassee—800,000 cu yd placed with one 7-yd cableway
Conchas—840,000 cu yd placed with two 4-yd cableways

Here, too, some instructive comparisons are possible. The best performance is quite evidently the Marshall Ford Dam, where one 8-yd cableway placed all the concrete. Considering that this cableway was also used to handle all embedded parts and other materials, the record is outstanding. Practically the same record was made at Norris but with a higher equipment cost, resulting from the two cableways. It may be stated that one 8-yd cableway might have done the job economically, but engineering requirements were originally set up to use two 4-yd cableways and a subsequent compromise was developed under which the capacity of each cableway was increased to 6 cu yd.

In the case of Hiwassee, a very consistent result was achieved with one 7-yd cableway. The output was considerably slower than for the two dams previously mentioned, largely because financing requirements called for a slower schedule and permitted the use of only two placing shifts a day. Otherwise a greater output would have been possible.

It is interesting to note that in the case of Conchas Dam, where two 4-yd cableways were used, the plant itself was quite economical but the time required to place the same volume was considerably longer than at Marshall Ford, Hiwassee, and Norris dams. It may be that the considerable difficulty encountered in foundation preparation may account for the low volume of concrete placed during the first six months.

Tygart Dam (Fig. 1) offered an interesting comparison because it was similar in size to Norris and Marshall Ford dams. It is significant to note, however, that at Tygart whirler cranes on a high structural steel trestle were used to place concrete, and it was necessary to open up the project on one side and begin foundation excavation and erection of part of the trestle while the river was crowded against the far bank. Subsequently, by river handling and partial placement of concrete at various strategic points, the foundation for the trestle was developed across the full width of the canyon. After this, concrete placement on all parts of the dam was feasible. It should be noted that because of this operation during the first year, the concrete placing plant never really got into production. In the first ten months only 300,000 cu yd were

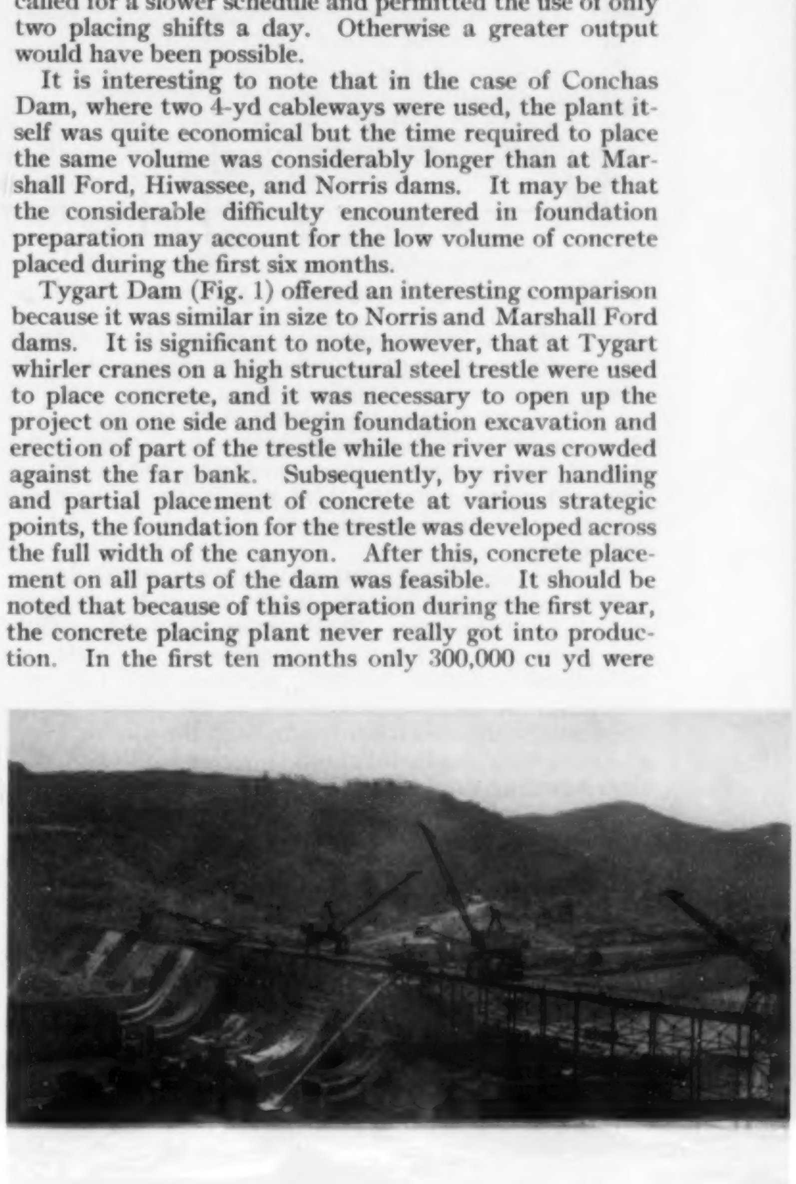


FIG. 1. TYGART DAM—A CANYON TYPE
Production Rate Influenced by
River Handling Problems

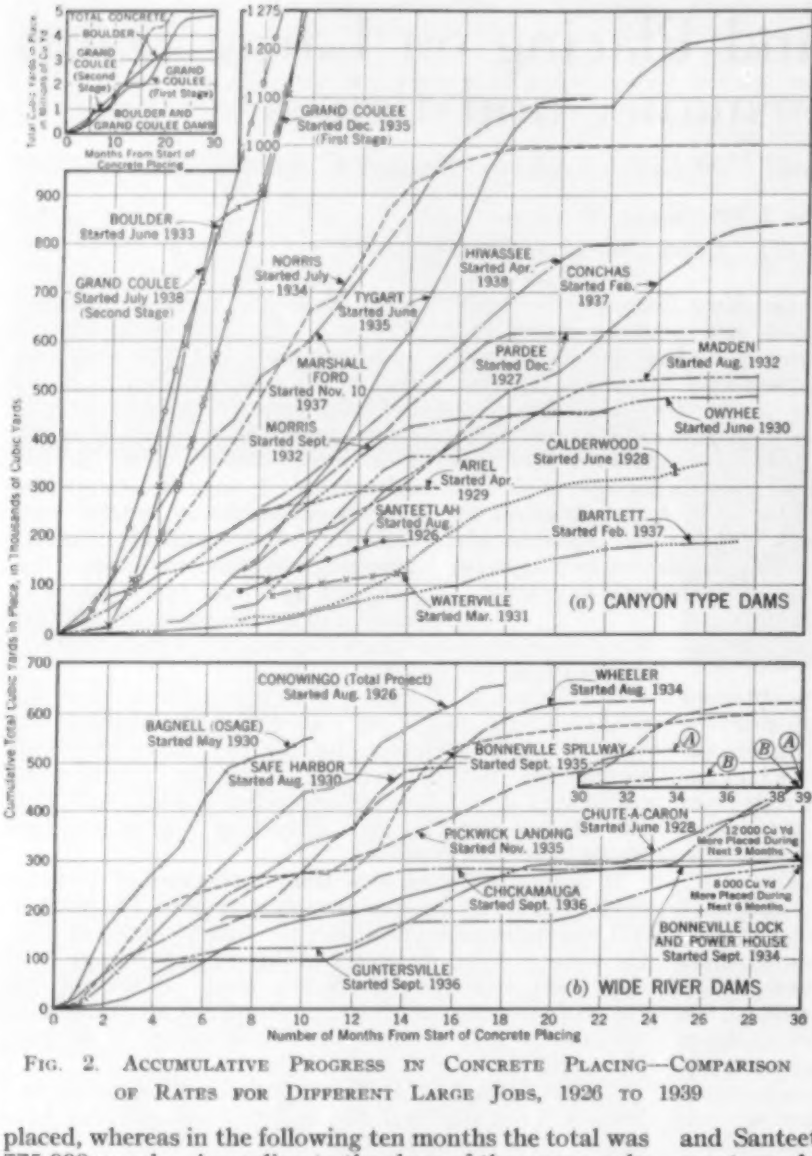


FIG. 2. ACCUMULATIVE PROGRESS IN CONCRETE PLACING—COMPARISON OF RATES FOR DIFFERENT LARGE JOBS, 1926 TO 1939

placed, whereas in the following ten months the total was 775,000 cu yd. According to the slope of the curve, only seven months of good concrete placing were obtained out of the entire concreting period of 31 months. Furthermore, for local reasons and limitations of plant at the start, it was necessary to carry over and place 175,000 cu yd of concrete during the third year, whereas the plant capacity was obviously adequate for completion at an earlier stage.

The most significant point, which may be restated here, is that cableways make the entire area of the dam accessible from the start. Furthermore, with the method and plant used at Tygart, it is necessary to locate the cofferdams and river handling facilities with full consideration for economical erection of the placing plant. This usually imposes a burden on both the placing plant and river handling installations, whereas with cableways river handling can be planned at its maximum economy.

These points, far from constituting a reflection on the methods used at Tygart Dam, may be considered rather as illustrating the difference of view that may exist regarding plant layout. Successful completion of the structure is a sufficient answer to any argument. It should be noted, too, that the choice of layout is not solely one of economics. It is just as important that the contractor have absolute confidence in the adopted methods and that he have assurance developed from a long experience that his organization can function most effectively with them.

The Pardee Dam is in a class by itself, with a record of 600,000 cu yd placed by tower and elevated chutes in a period when such equipment was still acceptable. The tower-and-chute procedure has now been almost universally displaced by bottom-dump buckets, which can better handle modern dry concrete with large aggregate.

In the half-million-yard group, the Madden Dam (525,000 cu yd) and Owyhee (480,000 cu yd) have similar characteristics, and each was placed with one 8-cu yd cableway. The general problems of both projects were similar, and it is interesting to note that in spite of a satisfactory cableway capacity, such as was used on Marshall Ford and Hiwassee dams, the concrete placing rate was relatively lower, for on both of these jobs the size of the project was such that river handling problems and the volume of individual concrete "pours" limited the over-all rate of progress. There were only a few months on either job when enough empty forms were available to permit concrete placement at a rate approaching plant capacity.

Morris Dam, with 450,000 cu yd of concrete, was probably one of the most economical projects ever built. Two 4-yd cableways were used, and the performance was somewhat better than at Conchas. The low cost undoubtedly resulted from the arrangement of the project and the general plant simplicity.

Both Ariel Dam (300,000 cu yd) and Waterville Dam (125,000 cu yd) were placed with whirler cranes. Calderwood Dam (350,000 cu yd) and Santeetlah (180,000 cu yd) were placed with guy derricks. Ariel and Waterville were built by one superintendent and Calderwood and Santeetlah by another, and the selection of equipment was largely dictated by their personal preferences. The use of guy derricks for such work has since become obsolete. In those days "coverage" of the job by placing equipment and "reach" from concrete transfer cars to forms were largely the primary considerations, whereas in modern plant layouts a substantial increase in plant investment has been justified in order to obtain not only "coverage" but also "continuity of optimum output." This is a sound policy since the first cost of equipment is a relatively small proportion of the total cost.

Bartlett Dam (180,000 cu yd) is of the multiple-arch type and the concrete was placed with a pump instead of the usual overhead facilities. Rate of placing and construction were relatively slow, but it must be noted that in a multiple-arch dam the erection of reinforcing steel and forms is the controlling factor.

Figure 2(*b*) shows cumulative concrete placing curves for various "wide river" dams. Only the largest built in the United States in the last 14 years are considered. Volumes of concrete run from 250,000 to 650,000 cu yd.

For convenience in discussion, consider in a first group Bagnell, built in $10^1/_2$ months, Conowingo, built in 18 months, and Safe Harbor, built in 16 months. The periods stated refer only to the time required to place the concrete and not appurtenant facilities. However, the records of concrete placed per month are remarkable and

TABLE I. COMPARISON OF WIDE-RIVER DAMS ON BASIS OF "UNIT COST INDEX"

	CONOWINGO	SAFE HARBOR	WHEELER*
Year built	1926–28	1929–32	1935–36
Length of structure, ft	4,648	4,862	6,335
Height, ft	110	78	72
Excavation, cu yd	353,000	345,000	555,000
(C) Concrete, cu yd	640,000	464,000	653,000
Total cost	$30,000,000	$16,400,000	$25,800,000
(A) Cost of structures holding back water—basis of comparison	$16,000,000	$ 9,800,000	$15,100,000
Percentage of total:			
Cofferdam	13.8%	7.1%	6.6%
Excavation	4.9	5.3	9.2
Dam structure	31.3	34.6	43.0
Spillway equipment	7.3	10.2	4.7
Highway over dam	3.4	0.0	5.5
Intake section	29.8	34.8	25.2
Intake equipment	9.5	8.0	5.8
Total	100 %	100 %	100 %
"*Unit Cost Index*" $\frac{(A)}{(C)}$			
Cost per "cu yd of concrete in dam"	$24.87	$21.12	$23.17
Cost per "cu yd of concrete in dam" with adjusted wage scale	26.48	23.69	23.17
Cost per "cu yd of concrete in dam" adjusted for both wage scale and aggregate cost	25.43	23.83	23.17
Weighted average cost of all concrete only	....	....	12.32
Conditions affecting cost	High cofferdams, hard rock, butterfly intake valves, advanced completion date	Built during depression, low price structure	Grouting of foundations, highway over dam

* Compensation, taxes, and interest during construction omitted.

the consistent monthly output shows good management. The significant feature of all three projects is that they are commercial hydroelectric projects undertaken after substantial blocks of power had been contracted for, and it was necessary to meet the schedule under those contracts. An increased expenditure for more rapid construction was justified to gain an additional increment of income as well as to reduce interest during construction.

In another group, consider Wheeler Dam (Fig. 3), built in 24 months, Pickwick Landing Dam, built in 30 months, and Bonneville spillway, built in 28 months. These were undertaken as navigation projects without commitments for power, and the rate of construction was largely defined by cofferdamming and river handling problems, which were quite severe in each case and had an important bearing upon the whole construction cost. It might well be said these projects were built during their "natural" construction periods at minimum cost. (There is also no fixed policy for considering "interest during construction" on such federal projects.)

The next group includes Guntersville Dam, built in 36 months, and Chickamauga (see cover), built in 39 months of concreting time. In both cases there was a deliberate delay to conform to available appropriations for financing the project. The Chute-à-Caron project was built in 35 months, in northeastern Quebec, where severe winter conditions imposed a shortened construction season. Here a difficult diversion problem also controlled the over-all time of building. The Bonneville lock and power house was built in 39 months, as permitted under the contract, largely because of the great amount of detailed work involved and the necessity for adjusting the rate of construction to available appropriations.

Of particular importance are the long periods near the end of each project (Fig. 2, *b*) when relatively little concrete is placed. Generally, finishing-up activities take place at that time, but most of the overhead, plant, and camp expenses continue, and are quite high. This definitely points towards the advisability of carrying on a certain amount of finishing up along with the "bulk" work so that the tapering-off period is reduced to a minimum, with a corresponding reduction in project cost.

Several years ago the writer had occasion to develop a basis of cost comparison that might show reasonably consistent results for various large projects. Just as the architect has the unit, "cubic foot of building volume," as an index for measuring the cost of various types of buildings, and the steel builder has a similar unit, "price per ton," for completely erected steel structures of various types, so in the present case the unit, "cubic yard of concrete in place," was designated as the "unit cost index" for complete dams. All available sources, including reports of federal agencies and published bids on projects, were investigated with the primary purpose of determining whether construction work done by public agencies was being handled as economically as that done by private enterprise.

For "wide river dams," listed in Table I, a consistent comparison of cost required that all labor and materials, all permanent equipment including spillway equipment, all temporary construction plant and equipment, camps, engineering, supervision, insurance, and compensation, be included. The comparison was limited to the structures which actually held back the water (see item *A*, Table I) and in this respect all three structures had similar characteristics and arrangements. Omitted were special structures peculiar to local conditions such as ice skimmer walls, tailrace extension, fishways, special highways,

TABLE II. COMPARISON OF CANYON-TYPE DAMS ON BASIS OF "UNIT COST INDEX"

	NORRIS*	OWYHEE	BOULDER	GRAND COULEE (1ST CONT)	TYGART	MORRIS
Year built	1933–36	1928–31	1933–38	1936–39	1935–38	1932–33
Length, ft	1,570	850	1,180	3,145	1,850	780
Height, ft	270	390	730	300	232	245
Excavation, cu yd	619,000	258,000	1,442,000	9,505,000	501,000	253,000
(C) Concrete, cu yd	974,000	524,000	3,407,000	3,511,000	1,113,000	462,000
Ratio of excavation to concrete	67%	50%	42%	270%	45%	55%
Total cost	$11,577,000	......	....	......	......	......
(A) Cost of contractor's service (basis of comparison)	6,374,000	3,200,000	25,280,000	25,770,000	6,158,000	1,911,000
"*Unit Cost Index*" $\frac{(A)}{(C)}$						
Cost per "cu yd concrete in dam"	$6.55	$6.10	$7.42	$7.34	$5.53	$4.13
Cost per "cu yd concrete in dam" adjusted for wage scale	6.55	6.34	8.15	7.01	5.63	4.66
Cost per "cu yd concrete in dam" adjusted both for wage scale and aggregate cost	5.97	6.47	8.15	7.01	4.63	4.88
"Unit cost index" comparable to wide-river dam index	11.90	....	....	....	....	....
Special conditions affecting cost	Manufactured aggregates		High cofferdam diversion cost	High cofferdam cost	No camp; no spillway equipment; high aggregate cost	No camp; no cofferdam expense; low aggregate cost

* Compensation, taxes, and interest during construction omitted.

FIG. 3. THE WHEELER DAM—A WIDE-RIVER TYPE
Built at a "Natural" Rate and Minimum Cost

power houses, and all power equipment and reservoirs. Of the comparable cost (item *A*, Table I) 27% was direct labor on which costs were further adjusted to correspond to the prevailing wage rates paid on the most recent project, using a weighted wage-scale factor. A similar adjustment was also made in concrete aggregate costs. The net result is very interesting because the "unit cost indices" are similar for all three projects.

A similar analysis of costs was also made on canyon-type dams, but the "unit cost index" was not the same as for wide river dams. For canyon-type dams, which were largely built by private contractors, only those prices represented in the public bid schedules were used. These contractor's costs included labor, construction equipment, supplies, river handling, camp, supervision, aggregate production, overhead, and profit, but omitted the first cost of all permanent equipment, cement, and machinery which was furnished by the public agency undertaking the work. Here again, for comparison, only that part of the structure holding back the water was used.

"Unit cost indices" for canyon-type dams are tabulated in Table II. They average around $6 to $7 per cu yd for the first four dams. The unusually economical results achieved on the Morris Dam (California) are evident by comparison. The low index figure for Tygart confirms the original surprise when bids were opened and it was found that the low bid was more than a million dollars under the next one. However, in the execution of the job increased quantities—particularly of excavation—resulted in a substantial increase in the total amount paid to the contractor. On a final basis the unit cost index was more in line with that of other jobs.

The information in Table III is of special significance in several respects. The table shows bid prices for foundation excavation, both common and rock, and for mass concrete, usually the principal items on large dam projects. On a number of the projects the unit prices appear reasonably consistent. On others the bid prices for excavation amount to more than the bid prices for concrete although the latter involves the preparation and handling of aggregate, handling of cement, mixing and placing of concrete, curing, form erection, and operation of a very expensive plant. The prices shown for Norris are actual costs and indicate typical relative costs.

High bid prices on excavation are usually set up to help finance construction of the concrete plant, for common excavation is one of the first operations from which a contractor can realize any income. If the early expenditures for opening up and getting the job under way became excessive, it is only natural that he will distribute some of the outgoing money into the bid items which will be undertaken at the outset in order to obtain a quick recovery of money as an aid in financing the construction plant and camp facilities.

It may be argued that such bidding, sometimes called "unbalancing," is improper, but it is important to the client or public agency for whom the work is performed that the contractor keep himself in a sound financial position, and the job must of necessity carry any financing expense properly chargeable to it. If the contractor must go to a bank for the money, he must usually pay a higher interest rate than is represented in the project funds paid out prematurely. Also, if he has bid his job so that it tends to finance itself, he has the bank's credit to support him in emergencies.

Where the quantities estimated in the bid schedule are accurate or reasonably close, the total cost of the job is not adversely affected by such bidding. Furthermore, when the same unit price is bid for common and rock excavation, much expense in separating the two materials for the sole purpose of measuring and classifying them for payment is eliminated. However, if it develops that foundation conditions were not properly explored, or are found to be less favorable than originally anticipated, so that the quantities of excavation materially increase, then the contractor gains an advantage at the high unit prices bid, and the agency or client correspondingly sustains a loss. In several instances this has run into very large sums of money.

On the other hand, it is within the control of the contracting agency to set up its bid schedule with separate items for such features as construction camp, concrete placing plant, access and distribution roads, water supply system, electrical system, and similar construction facilities, so that they can be paid for as constructed. In this way the necessity for carrying such costs as "excavation" would be avoided. It may be presumed that the agencies operating under current practices have found them acceptable, but it must be noted that this places a special obligation on the engineer to accurately survey the quantities set up in the bid schedule. A further implication of this entire discussion is that the published bid prices may have practically no significance as representing actual prices.

TABLE III. UNIT BID PRICES ON LARGE CANYON-TYPE DAMS

Project	Foundation—Common Excavation		Foundation—Rock Excavation		Mass Concrete (Cost of Cement Not Included)	
	Quantity Cu Yd	Unit Bid Price	Quantity Cu Yd	Unit Bid Price	Quantity Cu Yd	Unit Bid Price
Owyhee	135,000	$1.85	70,000	$4.00	490,000	$3.50
Madden	260,000	1.50	173,000	3.10	460,000	2.50
Boulder	857,000	2.20	400,000	4.40	3,400,000	2.70
Parker	1,508,000	0.70	83,000	2.70	260,000	3.70
Tygart	274,000	1.60	68,000	2.35	1,100,000	4.18
Conchas	81,000	0.60	72,500	1.50	602,300	4.20
Marshall Ford	450,000	2.00	310,000	2.50	910,000	3.10
Grand Coulee (1st)	11,000,000	1.00	800,000	2.00	3,100,000	3.00
Grand Coulee (2nd)	....	....	....	....	5,500,000	3.53
Shasta	660,000	4.00	1,500,000	4.00	5,400,000	2.80
Friant	100,000	3.00	580,000	3.00	1,850,000	2.48
Norris (*cost price)	182,000	0.55*	283,000	2.16*	885,000	3.37*

Primitive Houses of the Far East

"Flimsy" Structures Withstand the Typhoon; Interesting Details of Houses from New Zealand to the Philippines

By J. Charles Rathbun

Member American Society of Civil Engineers

Associate Professor of Civil Engineering, College of the City of New York, New York, N.Y.

A LEISURELY round-the-world tour, mainly off the beaten paths of travel, provides the background for this story of houses that a fourth of the world calls "home." Flimsy and ramshackle though some of them appear, Professor Rathbun points out that they meet well the exacting requirements of climate, customs, and available materials. The "skyscraper" details of some of these houses, and the mud-and-mat construction of others, have easily recognized equivalents in far more imposing structures of the Western world.

A VERY large percentage of the population of the earth dwells on or near the shores of the Pacific Ocean. Their homes are not large or elaborate but to a wandering engineer they have proved interesting as models of efficiency and adaptation to environment. They vary but slightly from one general pattern and this variation results from the need of using the material at hand in the most economical manner, or of conforming to climatic or other local conditions.

Although tribal customs have their requirements, the climate must always be reckoned with. Yet as one travels from the hot, humid tropics where the typhoon is common, to the cold winters that afflict the Maoris of New Zealand or the Chinese on the shores of the Yellow Sea, one sees a remarkably small variation in the fundamental concept of the house. The abandonment of leaves and grass for mud and tile as a building material seems to be influenced by availability of material rather than by climate.

Accompanying this article are a number of photographs taken by the writer, which serve to illustrate how the simple native, probably by the trial-and-error method, has learned to design a building that is the most efficient solution to his housing problem—with its exacting requirements of climate, customs, and superstitions—in spite of poverty of materials.

Over a large and thickly populated portion of the Pacific region the typhoon is a frequent visitor. This is the same type of storm that has wrought such havoc in Miami and Galveston in this country. The native shacks seem to be able to weather these gales with remarkably little damage, showing the superiority of the trial-and-error method of design over the more scientific one used by American engineers. At first glance it is hard to believe that one of these light houses can fail to be blown out to sea by a storm whose fury will damage vessels of thirty thousand tons, but the evidence is there.

In the tropical islands of the South Seas, in the Dutch East Indies, and in the Philippines, the native hut is for the most part a one-room, one-story structure. Its skeleton consists of a frame of vertical posts to which are lashed, or joined by mortise and tenon, horizontal wales. Over the posts is a horizontal piece as a cap, which supports the rafters of the roof. This roof is sloped upward to a ridge and ridge pole. One set of these wales may support the joists, which in turn support the floor. This framework supports the walls and roof, thus utilizing the modern principle of the skyscraper long before it was thought of in America. The walls consist of a matting of rice straw, leaves, or split bamboo. The resulting structure, although it has many drawbacks as a place in which to live, protects its occupants from the direct rays of the sun and from the rain.

Not only are these houses admirably fitted to the domestic habits of the natives but the initial cost is within the reach of the poorest. The materials are found close at hand and can usually be had for the taking. The labor that enters into the erection is largely the owner's own and is therefore commensurate with his standard of living. It would be difficult for a trained engineer or architect to improve on this simple solution of the housing problem or to find designs that would harmonize with the landscape more effectively.

Where the Chinese influence is felt the wall design may be changed. Instead of a frame wall supporting a covering, one finds a solid wall of sun-dried brick. Where stones of the right size and shape are more easily obtainable than brick, the walls are of stone laid dry, the holes between plastered with mud to keep out the wind. These walls support the roof frame, which in turn supports the thatch or tile as in the all-wood house. The floor, which is composed of compact earth, may not be raised.

Contact with the foreigner quickly shows in the dwelling of the native. He may take advantage of new construction materials or he may find his standard of living raised by an increased prosperity. It is necessary to get well away from the large cities to see the real native homes. This is particularly true in a place like Manila, where an organized campaign to educate the native has been in progress since our occupation of the Islands.

The natives of the Canal Zone have been in contact with the shipping people and with the builders of the Canal for many years, and hence have discovered that the short pieces of lumber from discarded shipping crates are an improvement over leaves and grass as a roof covering. The sheet-iron obtained from five-gallon oil cans that have outlived their usefulness as containers is often used to keep out the wind and rain, although it does not last long in this moist climate. Galvanized iron may be bought for roofing, and it has some advantages over the thatch; it is lighter, and fireproof. On the other hand, it is by no means so good as a heat insulator.

In New Zealand the native home is now but a museum piece. The people have been absorbed and civilized by the white invaders until their tribal customs have practically disappeared. The native life in Hawaii is also dominated by that of the later comers, and houses of the original type are hard to find. Some tribes, as in the Dutch East Indies, build frame houses of a peculiar local and quite elaborate design, but in general the simple structure is most common. Throughout the other countries and islands influenced by the Polynesian culture one finds that the framed house previously described is the most common abode. These frames are of bamboo or of a

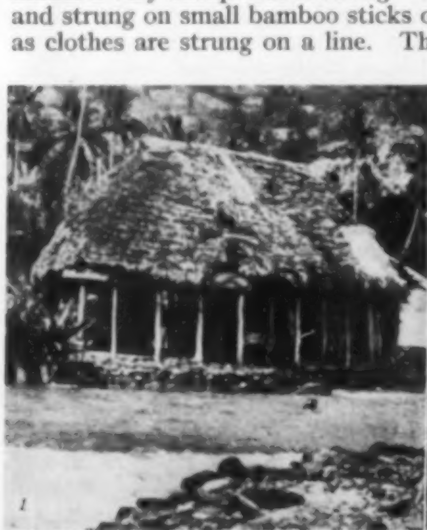
local timber which has been squared with an adz or similar tool. Instead of relying on the mortise-and-tenon, the builders prefer to lash the timbers at the joints. The method of lashing has been brought to such a stage of specialization that one who has made a study of these people can tell what tribe built the house by examining the ties. The relative merits of the two types of joint are of interest. The lashed joint can be constructed to resist more stresses due to storms than its more compact rival, and if the joints become loosened they can be repaired much more easily. The mortise-and-tenon lends itself to a neater framing design. The tree nail or wooden peg is used to a limited extent, in combination with the mortise-and-tenon joint.

In some localities where rain accompanied by wind is not frequent, the side covering may be omitted from the house entirely. The structure will then consist of a raised platform surmounted by a roof on posts. The platform may be of earth raised above the surrounding grade sufficiently to insure drainage, or it may be a wooden floor well above the ground. As the posts have no lateral bracing, they are usually set in the ground, although with a raised floor, an opportunity to brace presents itself. The roofs are heavy and thatched. The furniture, if it may be called such, is of such nature that it is not injured by an occasional wetting. This type of house provides a minimum of privacy but a maximum of ventilation, which is far more to be desired. Such houses are found in Samoa near the U.S. Naval Station at Pago Pago. Here the rains are heavy and frequent, but are usually not accompanied by wind.

For those living near fields of sugar cane, this grass makes a very cheap roof covering. The leaves are folded and strung on small bamboo sticks or tough vines much as clothes are strung on a line. They are then laid on the rafters or on the sides of the house like shingles, the carrier being lashed to the house frame. In order to prevent the fragile leaves from whipping in the wind and being soon destroyed, light bamboo poles are laid over them horizontally and lashed to the frame, so as to pin down the free ends. Such a covering can hardly be expected to last more than three years at the most, but once the frame of the house is up it takes little time and no money to recover it.

The natives of the Philippines, prior to the intensive civilizing work of the U.S. Government, built a house somewhat of this type, except that they used the leaves of the Nipa palm instead of the sugar cane. This leaf is far tougher and more enduring than sugar cane, and so a much more substantial and more permanent covering results. The house is raised above the ground a sufficient height to allow the space below to be occupied. This arrangement furnishes a place where the chickens, pigs, and other domestic animals can get out of the sun or rain. It also avoids a damp, unsanitary space below the house where snakes and other undesirable tenants might lodge. The floor consists of split bamboo, laid with the hard skin surface up and tied on bamboo joists. Such a floor is easily kept clean as all liquids and dirt fall into the space below. The air circulation beneath the house tends to keep it cool, especially as the floor is quite open. These Nipa shacks present an appearance of hopeless instability but their mortality is low in the typhoons that constantly pass over the Islands. The pride of the owner does not prevent him from putting a heavy shore against his house on the lee side if he knows from which quarter the wind will come. Of course he leaves it there as a necessary part of his home.

Bamboo split into thin strips about an inch wide and less than $^1/_8$ in. thick, and woven into a mat, forms an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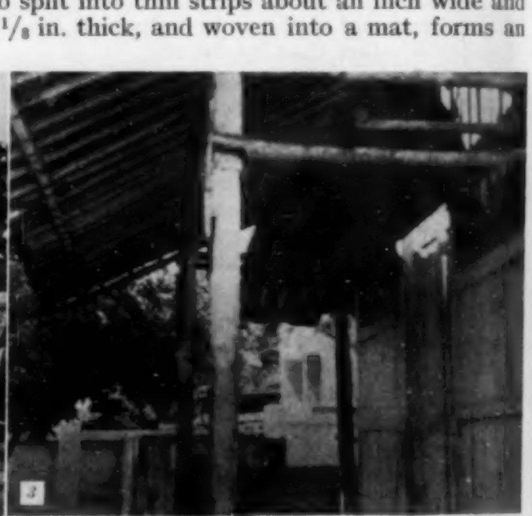
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(1) VENTILATION at the Sacrifice of Privacy. (2) Sugar Cane Leaves Make a Picturesque Covering. (3) Details of a House in Java, Showing Bamboo Roof-Framing and Hand-Sawn Siding. (4) Detail of Frame Bracing and Thatched-Roof Construction as Viewed from Beneath. (5) "Skyscraper" Design Characterizes This House Under Construction in the Celebes. Note How Posts Are Weakened by Mortising

excellent material for wall construction. This matting, manufactured and sold in rolls, provides a much neater solution to the problem of wall design than the nipa or sugar cane leaves. Very neat and permanent homes are constructed by building a frame of squared timber, with joints well made and the whole structure true to line. The walls, and the partitions also, are made of this matting. A better construction can be secured by using two layers of matting separated by the width of the framing. Very substantial one-story houses of this general type are owned by natives who have prospered, in a modest way, through employment in minor positions with the government or with commercial companies. The floor of these better-class houses is often made of wide planks laid with sufficient space between them to allow the dirt to disappear when the room is swept.

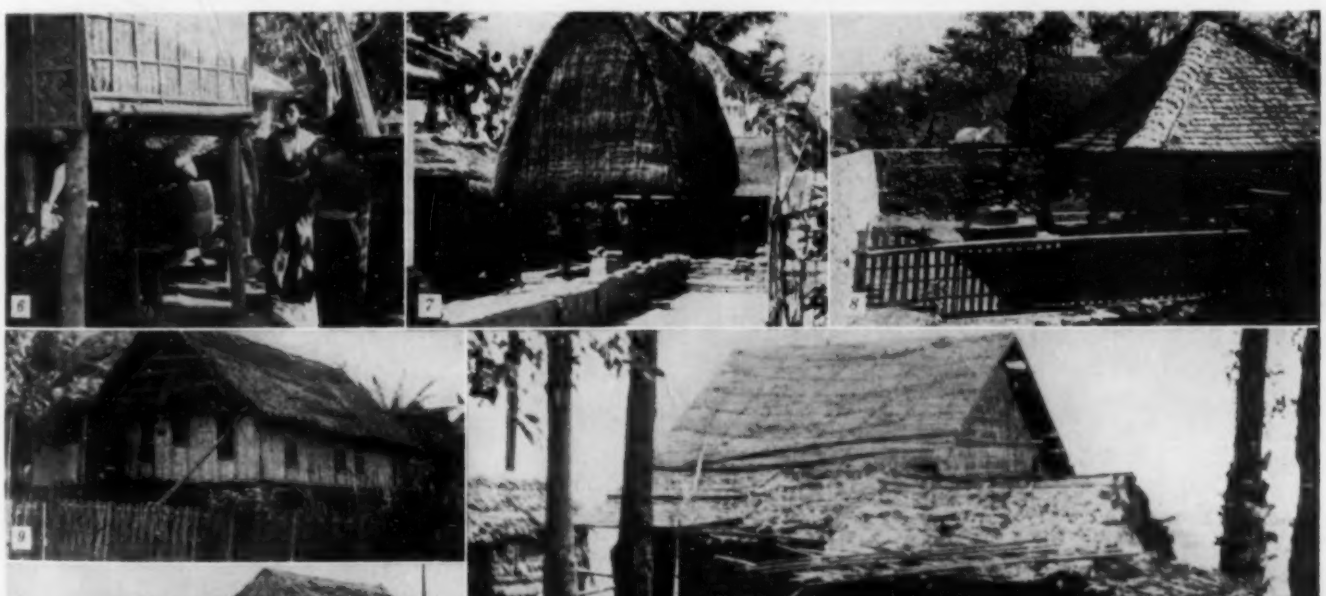
In Bali one finds a comparatively advanced form of civilization, and the single house is replaced to a considerable extent by the family compound. The home consists of several small houses surrounded by a wall built of baked or of sun-dried brick. (If of the latter, the wall is surmounted by a thatch or other form of permanent covering to prevent erosion by the rains.) This wall is often not more than shoulder high, but it serves as a definite boundary to the compound and prevents stray animals from intruding. The enclosed area is leveled off and the earth compacted. A section is partitioned off for the religious buildings. The living quarters consist of a number of small one-room houses, set above the ground by a distance that varies from just enough to insure ventilation and to permit the removal of stray animals, to high enough to provide a wall-less room for occupancy. Such a home furnishes little privacy, but as these people believe that "a virtuous person has nothing to conceal," and dress and act accordingly, this scheme of having each room a separate house is a very satisfactory if not economical solution for a tropical country. In addition it provides plenty of room for the women to work and the men to loaf or carve wood. The roofs are usually of thatch made of rice straw, but of late galvanized iron has become quite common. In some houses the roof is made of halved bamboo poles, with the diaphragms removed. These are laid side by side with the concave side up. Over them, with the concave side down, is laid a similar set of poles, forming a kind of continuous lock joint. Each strip is lashed in place to purlins of bamboo. The life of such a roof is about three years.

Bamboo split and woven roughly and loosely makes a sort of fence that is common in districts where this useful plant grows. Such a fence is not readily knocked over and furnishes an excellent protection against animals.

Windows are but openings in the wall. In some cases wooden bars are placed over them and, where protection from the weather is desired, they may be furnished with shutters, but more usually loose boards are available that can be fitted into the openings during rainy, windy weather.

In Northern Indo China one finds the mat walls thickly plastered with mud, the matting being used as a backing—a sort of forerunner of the metal lath method of construction. A house of this type with its thatched roof, earth floor, and few if any openings except the door (which is covered with a heavy mat), is quite well heat insulated although not well ventilated.

The Chinese are disposed to avoid the wooden house and to make their homes with sun-dried brick walls. A small opening for a window and another for a door furnish the ventilation. These openings are furnished with tightly fitting boards so that they can be closed at night



(6) Details of Framing and Siding on a House in Bali. (7) A Bali Storehouse, Thatched and Elevated. (8) Roofs of Halved Bamboo. (9) A House in the Celebes—Squared Timber Floor Supports, but the House Frame Is Bamboo; Note the Strut for Lateral Bracing. (10) Houses in Indo China, with Mat Sides Plastered with Mud. (11) A Home in Cambodia.

or during bad weather. The floor is of packed dirt. The roof may be the usual thatch or, where that is hard to get, baked clay tile, which forms a more permanent cover. These tile are well formed and make a neat solution to the problem. Where stones of suitable size and shape are easily obtained the soft brick is replaced with stone, and the openings are filled with mud. A cluster of these one-room stone houses with red tile roofs presents a very picturesque appearance when the village is on a hillside. The effect is accentuated by the Chinese lack of geometrical formality in their village plan. A few decades ago, before the emancipation of the Chinese women, each house had a court yard surrounded by a high wall where the family could be outside the house and still out of sight of others.

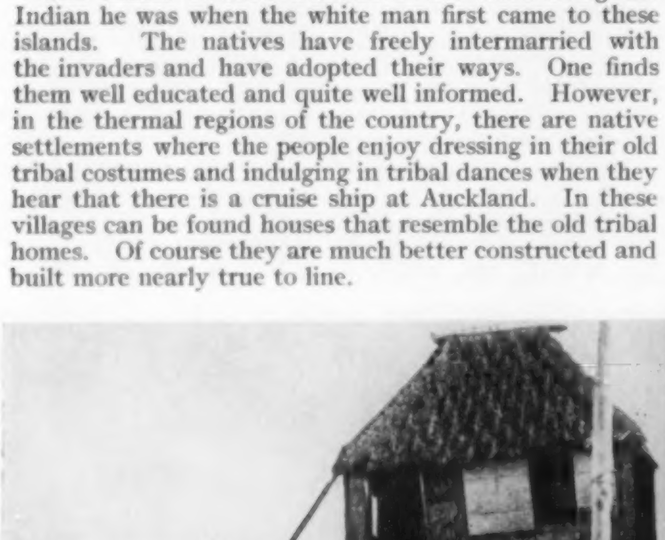
The "Black Man" of Australia is nomadic and does not build houses of any kind. He may, if he considers it necessary, secure temporary shelter from the rain by getting under a bush or tree on which additional boughs have been placed. As these people wear no clothes the rain bothers them but little unless it is also cold. It is hard to find Australian natives as they rapidly change their ways when in contact with the white people.

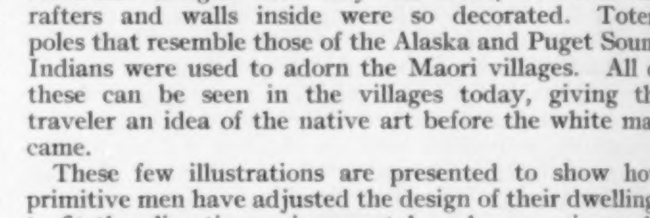
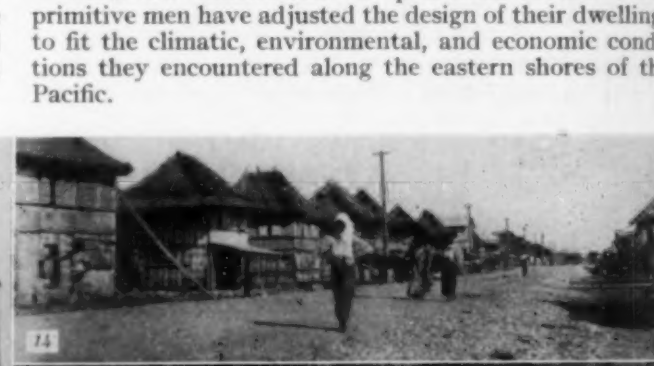
The Maori of New Zealand is far from being the Indian he was when the white man first came to these islands. The natives have freely intermarried with the invaders and have adopted their ways. One finds them well educated and quite well informed. However, in the thermal regions of the country, there are native settlements where the people enjoy dressing in their old tribal costumes and indulging in tribal dances when they hear that there is a cruise ship at Auckland. In these villages can be found houses that resemble the old tribal homes. Of course they are much better constructed and built more nearly true to line.

Originally the Maori house consisted of one room, and was a tribal home. The walls were built by setting planks as posts, edge to edge, forming a wall about three feet high. On this was laid a plank to support the eaves of the roof. A heavy ridge pole was supported by two upright posts. The roof was composed of planks one end of which rested on the ridge pole and the other end on the top of the wall. Across one end was a wall built like the side wall; at the other end, the wall was set a few feet back so that the overhanging roof formed a front porch. Often the whole house was covered with earth to insure insulation from the cold weather. No furniture was used nor was there any other outlet for ventilation than the small, covered door opening. A charcoal fire might be used to add to the warmth; this together with a crowd of unbathed Maoris produced so much atmosphere that often one of them would suffer a sudden collapse which of course would be attributed to causes other than the obvious one. When he was taken into the open air the evil spirits would usually leave him and he would recover. Such was the housing situation only a hundred years ago.

These houses were elaborately carved with a peculiar scroll-like design. Not only the front, but also the rafters and walls inside were so decorated. Totem poles that resemble those of the Alaska and Puget Sound Indians were used to adorn the Maori villages. All of these can be seen in the villages today, giving the traveler an idea of the native art before the white man came.

These few illustrations are presented to show how primitive men have adjusted the design of their dwellings to fit the climatic, environmental, and economic conditions they encountered along the eastern shores of the Pacific.




(12) (13) NIPA SHACKS in Manila Shortly After American Occupation. (14) Street in Ilo Ilo in 1914; Note Braces on Lee Side of Houses. (15) Chinese House in Yun-nan Province; Shed Is Roofed with Home-made Tile. (16) A Sample of Maori Carving—Front of a Store House.

Technique for a Survey of Old Sewers

Louisville, Ky., Institutes Thorough Inspection to Determine Flood Damage

By C. Frank Johnson

Associate Member American Society of Civil Engineers
Senior Engineer, Commissioners of Sewerage of Louisville, Ky.

Efficient performance under the extremely unpleasant and even dangerous conditions associated with a sewer survey is difficult to achieve. Mr. Johnson has emphasized here the numerous small but important details that contributed to rapid progress. He has also vividly illustrated the kind of deterioration that would probably be exposed in many other cities if similar investigations were to be made there.

During and immediately following the Ohio River flood of 1937 there occurred over 200 cave-ins of Louisville streets. Some of these were caused by the collapse of old sewers, and it was feared that considerable damage had been done to the sewers by the high internal pressures to which they had been subjected for several days during the flood, for in some cases the heads had been as high as 30 or 40 ft. To determine the facts and to estimate needed repairs and their cost, a detailed and careful survey was undertaken. As the conditions found to exist in the old sewers of Louisville are probably typical of those in other cities, it is thought that a summary of them and a description of the survey procedure followed may be of general interest.

The magnitude of the problem may be inferred from the fact that during the investigation 25.2 miles of brick and stone sewers were surveyed, inspected, and photographed. The sizes of these conduits ranged from 36 in. to 11 ft 9 in. in internal diameter for circular sewers, and from 30 in. wide by 45 in. high, to 4 ft by 6 ft for the egg-shaped sewers. Two rectangular stone sewers having a maximum size of 4 ft 9 in. by 6 ft 3 in. were included. In addition 3.2 miles of brick sewers smaller than 36 in. in diameter were inspected with the help of mirrors, and 9.2 miles of concrete sewers varying from 45 in. in diameter to 17 ft 2 in. by 25 ft 9 in. were given a detailed inspection. The age of the brick and stone sewers varied from 38 to over 87 years and that of the concrete sewers from about 10 to 30 years. Most of the brick sewers were of two rings and about 9 in. thick, but the largest sewers had walls of three-ring thickness. The depth to the invert of the brick sewers ranged from 6 to 25 ft, with the earth cover over the top of the arch ranging from 2 to 22 ft. Most of the sewers are in alluvial sand and gravel, although some are in clay. Nearly all of them are above the normal ground-water level, but of course they were more or less surrounded by water during the flood and in some instances for a time thereafter. The sewer slopes are fairly flat with a few exceptions, and all the sewers inspected are of the combined type except for one concrete intercepter.

At the outset it was decided to make the investigation as complete as practicable and to secure as many data as possible to supplement the meager city records. Accordingly a procedure was outlined for obtaining:

1. *Cross sections* showing the actual shape and dimensions of the inside of each sewer, to be taken at points not over 100 ft apart, but particularly where distortion of the sewer barrel was evident. These measurements were made with a 14-in. cardboard protractor mounted on a light plywood board. This in turn was mounted in an adjustable manner on a wood strut wedged in place in the sewer as shown in Fig. 1. Distances from the center of the protractor to the sewer wall were taken around the perimeter at intervals of 30° or less. A small $^3/_4$-in. square hardwood measuring stick, on the reading end of which were nailed pieces of a folding rule showing feet and hundredths, was used. The outside end of the stick was shod with a somewhat pointed metal cap for protection against wear. In 36-in. sewers the protractor was not used; the dimensions of the sewer section were merely measured with an inside rule on four diameters. A typical cross section showing deformation of the sewer wall is also shown in Fig. 1.

2. *Alinement* of the sewer, determined by measuring the offset between a transit line in the sewer and the center of the protractor when set in position. In sewers too small for regular or collapsible tripods, the transit was set on a home-made tripod having legs 22 in. long and a regular tripod head for the transit. Alinement was measured in all sewers except those of 36-in. diameter and smaller.

3. *Profile* of the sewer invert, secured by use of an ordinary wye level, using a home-made short tripod and a mine rod in the small sewers. The levels were run inside the sewer from manhole to manhole, utilizing the top of each manhole cover as a bench mark, the elevation of the manhole covers having been previously determined. A profile was taken in all the sewers except those 36 in. in diameter and smaller. A typical profile is shown in Fig. 2.

4. *Photographs* of the interior of the sewer, taken particularly where defective conditions were found, but also at regular intervals elsewhere. A small "candid" camera (f 3.5) was used with flash bulbs. About 1,800 photographs were taken.

5. *Detailed description* of the condition of the inside lining or wall of the sewer, including missing and loose bricks, condition of mortar joints and hardness of mortar, worn bricks and holes, de-

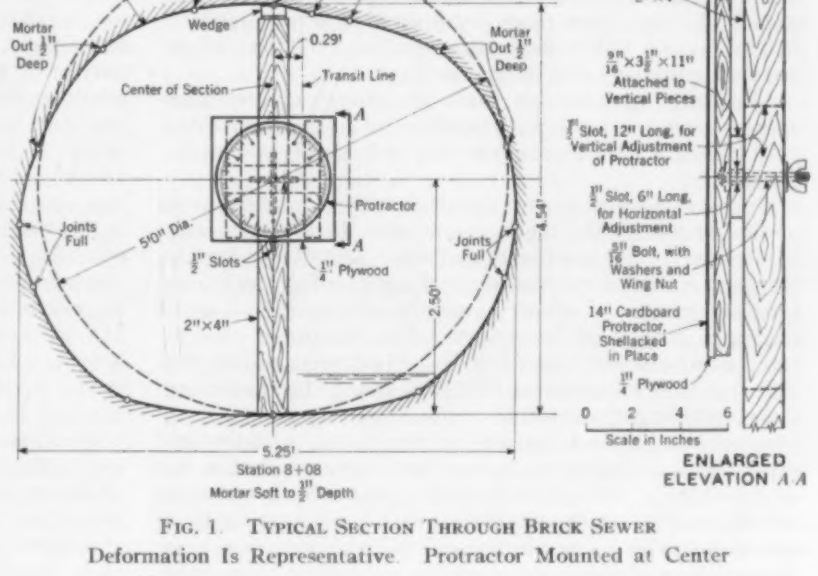


Fig. 1. Typical Section Through Brick Sewer
Deformation Is Representative. Protractor Mounted at Center

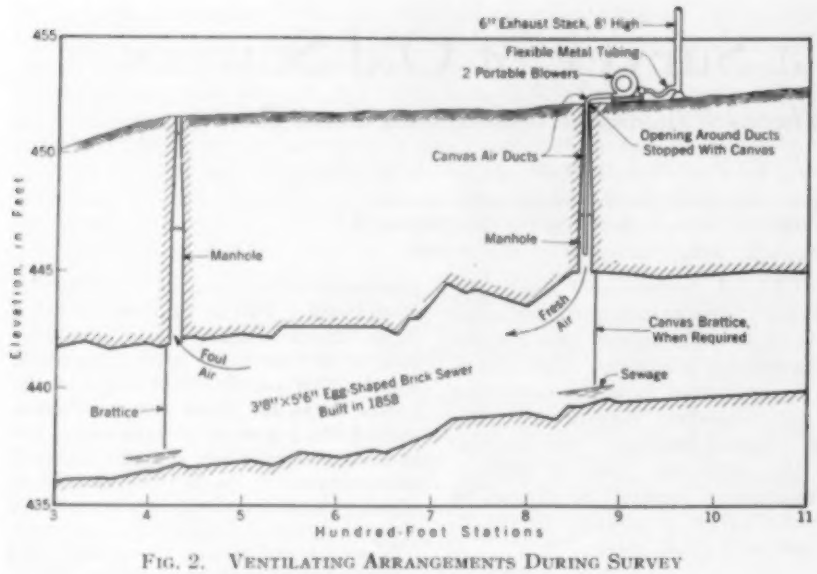


FIG. 2. VENTILATING ARRANGEMENTS DURING SURVEY

ormation, or cracks in the sewer wall. All inlets and lateral sewers visible during the inspection were located and described, as were any ground-water leaks that appeared. Depths of sewage flow and of earth or other deposits on the invert and the condition of the street surface above the sewer were noted.

6. *Borings* alongside the sewer, made at intervals of about 800 ft and wherever the walls of a sewer showed bad distortion. These borings were made to determine if ground conditions had affected the sewer structure.

APPROPRIATE STAFF ORGANIZED

A special subdivision of the Engineering Department of the Commissioners of Sewerage of Louisville was set up for the investigation. The work inside the sewers was carried on by two separate crews of 13 men each, the crews working independently of each other. Each crew contained an engineer-in-charge, an air inspector, a mechanic, two laborers, and two complete surveying parties of four men each. The surveying parties comprised a chief-of-party, an instrumentman, and two chainmen or rodmen. Each crew was provided with a truck capable of transporting all the equipment plus four or five men, and the other men traveled in passenger autos.

Above ground, a surveying party of three men ran bench-mark levels and did other necessary surveying work. Borings were made by a crew of a foreman and two laborers. Office work was handled by a force of six or seven engineers and draftsmen.

The strict precautions taken to guard against accidents have been described elsewhere (*The American City*, July 1938, page 41), but a few may be logically re-emphasized here.

An air inspector accompanied each crew, making tests of the air before the men entered and during their stay in the sewer. He used standard mine safety instruments, testing for carbon monoxide, hydrogen sulfide, and combustible gasses. Carbon monoxide was found in small amounts in most of the sewers. The maximum encountered in any sewer was 0.008%. Hydrogen sulfide was detected in few instances, 0.0022% being the maximum. Combustible gas was found in quantities up to 96.0% explosive. Each crew had emergency rescue and first-aid equipment, including an oxygen breathing apparatus and an inhalator. Two gasoline-driven, portable blowers each of 2,000 cu ft per min capacity for each crew supplied fresh air to sections of sewer in which men were working. Sewers were divided into sections extending from manhole to manhole, and the blowers operated between manholes in the manner shown in Fig. 2. The men were provided with all necessary accessories for protection and comfort, such as rubber waders, short rubber raincoats, latex gloves, micarta helmets, goggles, respirators, kneepads, etc. Each man used an electric cap lamp of 66 cp mounted on the helmet and powered by a storage battery carried on his belt. Rope ladders, life lines, and life belts were also furnished to each crew.

The safety measures were highly successful, for of the three or four minor accidents that occurred the worst was a sprained arm. Several times the bad air caused headaches and smarting eyes, and occasionally a man would become somewhat sick for a short time. However these conditions were always overcome, and work was continued after eliminating the bad air.

To guide the parties in the field, pencil drawings based on old city records were prepared on 20- by 36-in. transparent paper sheets, each sheet showing the street location and profile of a sewer. Before each crew started work on a particular sewer it received a blueprint of the sheet or sheets showing that sewer. The underground crews and the boring crew were also given lists of manhole locations by station and manhole cap elevations for use as bench marks.

The usual procedure was to send the underground crew's truck out first every morning, with the equipment, air inspector, mechanic, and two laborers. These men would place the blowers and start them operating at the location previously selected for beginning the day's work. The air inspector would test the air in the sewer both before and after the blowers were started. After the blowers had been operating for 10 or 15 minutes, and as soon as the air was shown by tests to be safe, the laborers would enter the sewer and install the brattices at the manholes between which work was to be done. After the crews became experienced it was found that in some instances the brattices were not necessary and could be omitted in order to save time. However there was no let-up in safety precautions.

After the blowers had been operating for a short time, the two surveying parties of the crew would arrive on the job and enter the sewer. One party then chained through the section being examined to establish station marks every 100 ft on the side wall at a convenient height. The other party followed, making a detailed inspection and record of the condition of the inside of the sewer and securing the other information desired. On

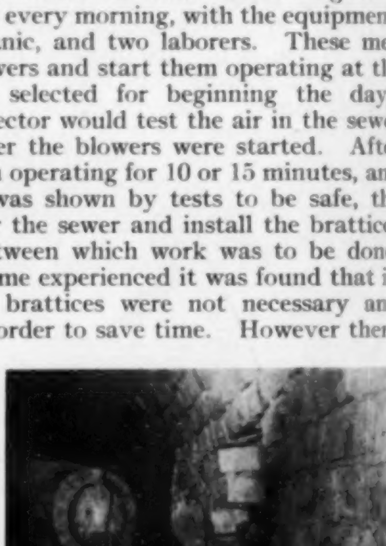


FIG. 3. BREAK THROUGH WALL CONSTRUCTED IN 1874
A Considerable Cavity Is Found in Back of Bricks

completing the stationing work, the first party ran a profile of the sewer invert over the same stretch. When this party finished the profile, it started taking cross sections of the inside of the sewer as previously described. If the other party completed the inspection work in time, it also took cross sections until all work in the section was completed. Then the blowers and other equipment were moved to the next section of sewer, and were followed by the two surveying parties. The procedure was varied in the small sewers where the two parties could not conveniently pass each other.

One man, chosen because of his amateur interest in photography, took all photographs. He worked alternately with each crew, traveling back and forth in a light automobile truck. To guard against the possibility of an explosion when the flashlight photographs were taken, there was an ironclad rule that before a flash bulb was used the combustibility of the air at that point must be measured. No photograph was allowed to be taken where the air measured more than 10.0% explosive. Occasionally a flash bulb would crack or burst, probably from moisture on the bulb, but in no instance was there an explosion of the air in the sewer.

Fig. 4. Arch Sag in "Circular" Section Built in 1867
Much of Inner Ring Gone, More Going

As the data were secured they were recorded on looseleaf notebook sheets in the field. These were later plotted in the office. The plan and profile data were placed on the same transparent paper sheets previously utilized for the preliminary plans and profiles. The final data in some instances showed considerable difference from the preliminary information taken from the old city records. Mortar conditions and other information secured were recorded at each cross section, as indicated in Fig. 1. When all this material had been compiled, listed in detail, and summarized according to each sewer inspected, the result comprised a typewritten report of about 1,200 pages in four bound volumes.

The brick and stone sewers were found to be in much better condition than had been anticipated. They had suffered little or no direct damage from the flood except at certain scattered points where washouts and cave-ins had occurred. In a few instances the entire sewer arch or side wall was gone, as shown in Fig. 3. At two or three points the earth above the hole was entirely gone, leaving an unsupported street pavement above. These points required emergency repairs, while many other points were found where short stretches of the sewer were in a condition approaching failure, but where repairs could safely be postponed, possibly for a few years. At these places, the difficulties were mostly sagging arches, side walls bulging in or out, and points where large sections of the inner ring of brick had fallen out and been washed away as illustrated in Figs. 4 and 5.

In some sewers the mortar was found to be gone from many of the joints to depths varying from a fraction of an inch up to the entire thickness of the wall, although the latter condition was comparatively rare. At some points the mortar had apparently disintegrated and had fallen or been washed out of the joints gradually during the life of the sewer. This condition also is shown in Fig. 5. On the other hand many of the mortar joints were found to be as good as the day they were made. When it remained in place, the mortar was found in some instances to be soft to varying shallow depths, while in others it was quite hard.

In a few places, mostly on steep grades, the invert bricks appeared to be worn, but the erosion was slight. Few transverse cracks were observed in the walls, but numerous longitudinal cracks, some of them very wide, were found extending along the center of the arch, in some cases for long stretches. At some of these points the bricks on one side of the crack were lower than those on the other—a dangerous condition. These longitudinal cracks occurred primarily in the largest sewers.

Most of the cross sections of the circular brick sewers showed a horizontal diameter larger than the vertical diameter, the difference in some cases being considerable. This condition indicates that the sewer side walls had moved outward until they were supported laterally by the passive earth pressure. At such points the sewer arch had lowered and somewhat flattened.

Probably the defective condition most universally found was at inlets, lateral sewers, and house connections, where in literally hundreds of cases the sewer wall was in bad condition around the opening. Bricks were loose or missing, and mortar was out of the joints, in some cases washed out by the flow of sewage from the inlet. The inlets themselves were often defective, with cracked or crushed pipes, loose bricks, or missing mortar in pipe and brick joints. There were other defects too numerous to detail. Typical of these inlet conditions is the one shown in Fig. 6. Deterioration of this kind was probably caused in many cases at least by poor workmanship in making the connections, for many of these had apparently been made at various times after the sewer was built by cutting a hole in the sewer wall. When the inlets had been completed the sewer wall apparently was not properly repaired. The weakened places gradually became worse, and local failure occurred when the sewer was submerged during the flood.

At a great many places in the brick and stone sewers it was found that holes, some small, some large, extended entirely through the sewer wall to the earth outside.

FIG. 5. AN EGG-SHAPED SEWER OF 1874
Above, the Flattened Arch; Below, Mortarless Joints

Some of these holes were at joints between the bricks or stones, some were caused by missing bricks or stones, and some were in or around inlets. At many of these points it could be seen that the earth had been coming into the sewer through the holes. Such places unless repaired would lead to future cave-ins.

Seventy-seven bricks, varying in age from 30 to over 87 years, were taken from the walls of 20 of the sewers and tested for strength and for absorption. The results were compared with similar tests made on modern bricks that are required to have a maximum absorption of not more than 10.0%. The maximum absorption of the old bricks varied from 12.3 to 42.4%, with an average of 25.0%. In compressive strength, 44 bricks tested varied from 1,770 to 9,200 lb per sq in., with an average of 4,600 lb per sq in., which is 69.0% of the compressive strength of the modern bricks. In modulus of rupture 41 bricks tested varied from 262 to 1,500 lb per sq in., with an average of 750 lb per sq in., or 59.0% of the modulus of rupture of the modern bricks.

The investigation of the concrete sewers was not as complete as that given the brick sewers. However, a thorough inspection was made, and notes and photographs were taken showing the condition of the sewer walls. Except for two stretches these sewers were in excellent condition. One of the damaged places comprised about 100 lin ft of unreinforced concrete sewer 30 years old. It was found to be badly cracked where it passes under a railroad fill. The other unsatisfactory stretch was a longer section of the same sewer less badly cracked.

There was little or no damage to the concrete from acid or other wastes except in two comparatively new sewers carrying whiskey distillery effluent. Here the concrete below the normal water line had been attacked; the original surface was eaten away to depths up to one-eighth of an inch; and the remaining under-water surface had been somewhat softened. As in the brick sewers, many of the inlet and lateral connections were found to be defective. In fact several cave-ins at connections required expensive repair work.

Both underground crews maintained remarkably consistent progress. Working 8 hours a day, the average daily progress in carrying on the underground part of the work from beginning to end (including lost time) was 935 lin ft of sewer surveyed and inspected per crew per day, or 1,870 lin ft per day for the two crews. The elapsed time from beginning to the end of the field work was 24 weeks, during half of which only one crew was used. Thirty-six weeks elapsed from the start of the investigation to the completion of the final report.

SURVEY RESULTS INTERPRETED AND DIRECT RECOMMENDATIONS MADE

The conclusion reached as a result of the investigation was that the old sewers suffered very little direct damage from the flood. Such damage as did occur resulted primarily from the fact that the sewer walls had previously deteriorated, partly from old age but mostly from poor construction (particularly of inlet connections). When they were then submerged for several days, the walls failed at some of the weakened points. It was apparent also that there were still hundreds of places in the sewers where repairs should be made soon in order to prevent future cave-ins.

Following the investigation it was recommended that certain stretches of the brick and stone sewers, which were in the worst condition, be reconstructed. The length recommended for reconstruction was 1.19 miles, or only 4.2% of the total length of brick and stone sewers inspected. This 1.19 miles was composed largely of egg-shaped brick and rectangular stone sewers, and included only 800 lin ft of circular sewer. It was recommended that the remaining portions of the old sewers be repaired, at a comparatively small cost, by patching from inside.

The survey and investigation was made by the Commissioners of Sewerage of Louisville, under the direction of Woolsey M. Caye, M. Am. Soc. C.E., technical engineer for the commission. The work was done under the immediate direction of the writer.

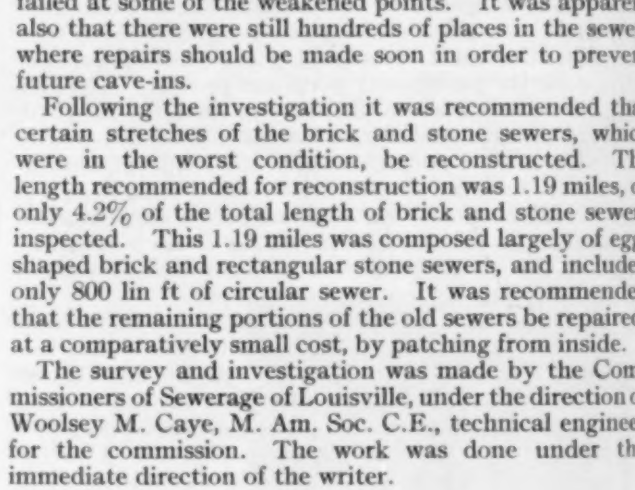


FIG. 6. INLETS—SOURCE OF MANY BREAKS
Cavity Forming Behind Brick Indicated by Settlement Under Pipe

Survey of Foundation Construction Methods

Columnar Piles, Sheet Piles, and Excavating Shafts of Many Kinds Meet Needs of Widely Differing Underground Conditions

By Ralph H. Chambers
Member American Society of Civil Engineers
Consulting Engineer, New York, N.Y.

With the increasing specialization in all branches of engineering, the difficulty of retaining perspective grows. Reviews of the kind presented here by Mr. Chambers serve to simplify the task of orientation and at the same time to acquaint newcomers to the field with useful expedients they might otherwise overlook. The article deals primarily with foundations involving considerable penetration of unstable materials, and discusses the relative applicability of different processes, construction materials, and equipment.

Except when loads are very heavy, a pile foundation is frequently the cheapest means of providing adequate support for a structure. For the lighter loads, wood piles can be used if they will always be submerged in ground water. If the piles are to project above this level, they may be composite—wood piles driven down below water level with concrete extensions cast in place upon the wooden butts after they are driven. For heavier loads, concrete piles, steel H-sections used as piles, or concrete-filled pipe piles find frequent application.

Concrete piles are of two general types, those cast and cured before they are driven and those cast in place in the ground. The latter are formed in the hole made by driving into the ground a steel mandrel or a steel pipe closed at the bottom by a removable plunger. These pipes are pulled out and the resulting holes are filled with concrete. To support the sides of the holes and protect the green concrete during the driving of subsequent piles, the holes are, preferably, lined with a thin steel shell which is driven with the mandrel or is inserted into the pipe after the plunger has been withdrawn and before the pipe is pulled.

Pre-cast piles are used under water or in very unstable ground or where the piles must project some distance above the ground level.

Pipe piles consist of steel pipes which are driven open ended, usually to bedrock. The material enclosed by the pipes is cleaned out by compressed air jets (or sometimes by earth augers, orange-peel buckets, or water jets), and the pipes are filled with concrete. Pipe piles are frequently used for underpinning structures whose foundations have proved inadequate. The piles are jacked down against the weight of the structure above in short lengths placed one above another as the jacking proceeds.

Wood piles will carry safely a load of 15 to 20 tons per pile, depending upon their lengths, the diameters of their points, and the strata into which they are driven. The carrying capacity of concrete piles is usually rated at 30 tons per pile. Steel H-section piles, which depend for their support on friction, are equivalent to concrete piles in carrying capacity. When they are driven to rock their capacity may be taken as equal to the area of their cross-sectional depth multiplied by the width, on the basis of 60 tons per sq ft. Accordingly their capacity will range from 30 to 90 tons per pile. Steel pipe piles 18 in. in diameter and driven to rock have an allowed capacity of 120 tons per pile, whatever the depth to which they are driven. This capacity may be increased by adding to the thickness of the pipe shell or by increasing the diameter. The capacities of pipe piles of smaller diameters, provided that their driven lengths are not more than 40 times their diameters, are rated more or less in proportion to their diameters and the thickness of their shells. Pipe piles driven to hardpan, according to the building code of the City of New York, have capacities of 70% of their values when driven to rock.

It must also be remembered that, whatever the capacity of a single pile, the capacity of the foundation as a whole, except in small clusters, cannot exceed the capacity of the ground stratum beneath. To illustrate—a wood pile may carry 15 to 20 tons. If such piles are spaced horizontally 30 in. center to center, the load will be equivalent to 2.4 or 3.2 tons per sq ft of the horizontal area of the supporting stratum. For such a load this stratum should consist of fine dry sand, medium wet sand, or material of coarser grain. If concrete piles are used, each carrying a load of 30 tons and spaced 30 in. apart center to center, the load transmitted to the foundation stratum will be equivalent to 4.8 tons per sq ft—almost twice the load that should be imposed upon medium or fine sand.

Wood piles, in place, usually cost 50 to 80 cents per lin ft, depending upon their lengths, the prevailing labor rates, and the cost of materials. Concrete piles, cast in place, will cost $2^1/_2$ to 3 times as much as wood piles and will carry only about twice as much load. Wood piles therefore will usually be cheaper. When, however, large numbers of wood piles would be needed under each of the foundation footings, it may prove cheaper to use concrete piles, provided the supporting stratum is of sufficient capacity, because of the saving in the size and costs of the caps which distribute the loads to the piles. Pre-cast concrete piles will cost more than cast-in-place piles without furnishing additional carrying capacity.

The cost of H-section steel piles may be $1^1/_3$ to $2^1/_2$ times that of concrete piles, depending upon the cross-sectional area of the steel. This is because the loads they would usually carry in friction are not more than concrete piles would carry. When driven to rock, however, the carrying capacity of the steel piles may be as much as three times that of concrete

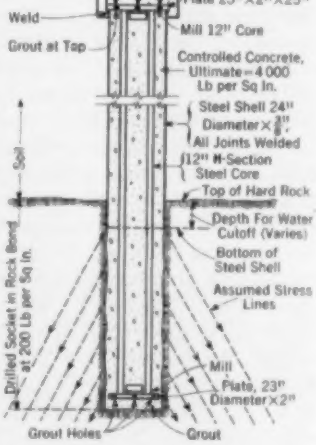


Fig. 1. Special Piles for 1,500,000-Lb Load

Steel Shell Encloses H-Section Encased in Concrete for Department of Sanitation Building in New York City

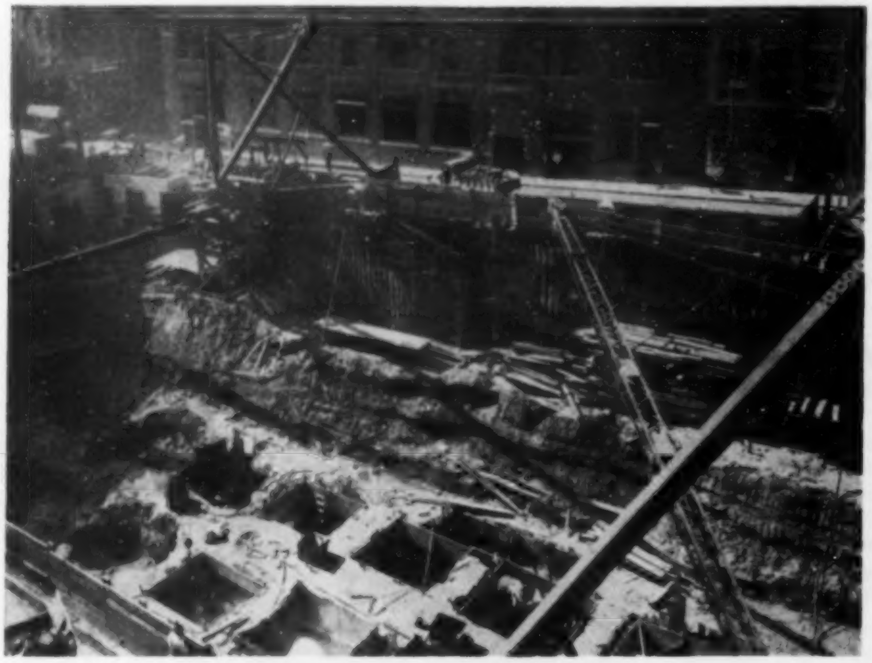


FIG. 2. STEEL SHEET PILING FOR COFFERDAM WALL
Excavation for Tower of No. 60 Wall Street Carried to Rock Around Entire Site—New York City

piles and half or two-thirds as much as that of pipe piles. Their relative cost may, therefore, be less than that of either concrete or pipe piles.

Pipe piles will cost $4.50 to $7.50 per lin ft, depending upon their diameters and other conditions. When driven to rock they will carry two to four times as much as concrete piles and will cost three to four times as much. They can, nevertheless, frequently be used to advantage, particularly because of the possibility of achieving a considerable saving in the cost of pile caps.

HEAVY LOADS REQUIRE SPECIAL TREATMENT

A recent use of pipe piles specially adapted to unusually heavy loads is illustrated in Fig. 1. The outside shells were steel pipes 24 in. in diameter driven to rock and cleaned out in the usual manner. Below each of the pipes, by means of a cable-operated churn drill, a hole of the same diameter as the pipe was drilled into the rock, and the pipe was driven into the hole to a distance sufficient to cut off the inflow of water. The drilling into the rock was then continued for some distance below the bottom of the pipe. A steel H-section core was lowered into each pipe until its base plate rested upon a bed of rich grout in the bottom of the hole in the rock. The holes in the rock and the pipes above were then filled around the steel core to the top with concrete. The load was thus carried to the rock by means of a casing pipe, the concrete, and the enclosed steel core. A part of this load is transmitted to the rock by direct bearing in the bottom of the drilled hole. The remainder is carried to the rock by bond between the steel core and its enclosing concrete and between this concrete and the walls of the hole drilled in the rock. Piles of this character were used to carry loads of 750 to 1,000 tons each. The bond stress allowed was 150 to 200 lb per sq in., and a test made in New York City in 1937 developed a bond stress of 385 lb per sq in. without failure.

When the loads are very heavy, or when pipe piles cannot be driven to rock because of overlying boulders or hardpan, it is frequently necessary to carry the foundations to the rock. The difficulties that arise in the construction of such piers are usually caused by the presence of water and fine materials in the ground. When there is no water, as in some of the prairie regions of the western part of the United States, excavations for foundations can be made to rock through the dry loess without supporting the sides of the pits. The foundations for the Nebraska State Capitol in Lincoln, Nebr., were carried down to the Dakota sandstone in cylindrical pits with unsupported sides to depths of as much as 50 ft.

Even when there is a considerable quantity of water in the ground, excavations through materials of coarse grain, or fairly stiff clay, can be made in the time-honored manner by using wooden planks to support the sides. Excavations of this kind are limited to depths of about 20 ft, unless they are made sufficiently large at the top to permit the starting of a second drive of planks when the excavation has reached the bottom of the first.

In parts of the regions occupied by the cities of Chicago and Detroit and in some others where the rock is overlain by a thick stratum of moist clay, it is possible to reach the rock in open excavations by lagging the sides of the pits with wooden staves. The excavations are made circular, in horizontal section, and frequently are of considerable diameter. They are made by hand labor and have been carried down to depths of 100 ft or more. The procedure is called the Chicago method.

At the bottom of each 5 ft of depth, the excavation is suspended until the lagging of the sides of the pit has been completed. The staves are usually of maple, 6 in. wide and 2 to 3 in. thick with beveled edges. They are held against the sides of the pits by steel rings made in quadrants and bolted together. The pits are then filled

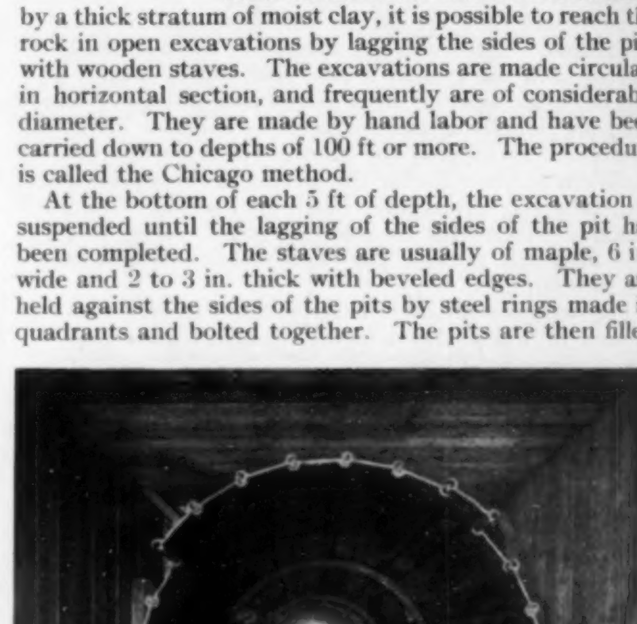


FIG. 3. THIS WAY DOWN
For This Pier Excavation, Horizontal Wood Sheeting Was Used to Ground-Water Level, Steel Sheet Piling Below

with concrete, and in some cases the rings and staves are removed as the concrete is placed. When the ground is of such a character that this method can be used, the excavations can be made to comparatively great depths at relatively small cost, but when water or running ground in considerable quantity is encountered, it is not feasible.

If the material to be excavated is saturated fine sand or soft clay, excavations can be made by surrounding

Fig. 4. Another Type of Circular Caisson
Steel Cylinder Jacked Down in Sections as Excavation Progressed for Manhattan Company Building, New York City

the site with interlocking steel sheet piles, as shown in Fig. 2. The sheet piling is set up, with the edges interlocked, around a timber frame on the ground surface. The sheet is then driven piece by piece, a few feet at a time, progressively around the site until the piles are down. The piles must reach or penetrate an impervious or coarse-grained stratum in order to intercept the flow of soft materials from the surrounding ground. Excavation is begun after driving is completed and after the piling is braced horizontally. If there are many boulders in the ground, this method may prove impracticable. Some pumping is usually necessary. Under favorable conditions depths of 60 to 75 ft, or even more, may be reached.

When the level of the ground water is at some distance below the surface, wood sheet piling may be used down to water level and steel sheet piles below. Or, when the horizontal dimensions of the excavation are small, wood sheeting placed horizontally may be used down to the water level, as in Fig. 3.

Instead of sheet piling, steel cylinders can be driven or jacked far enough below the bottom of the excavation to cut off the flow of water that might carry fine materials into the excavated space. This modification is used particularly in underpinning operations where, to conserve headroom, the cylinders may be fabricated in short lengths to be placed one on another as they are jacked down against the weight of the building above. This kind of treatment is illustrated in Fig. 4.

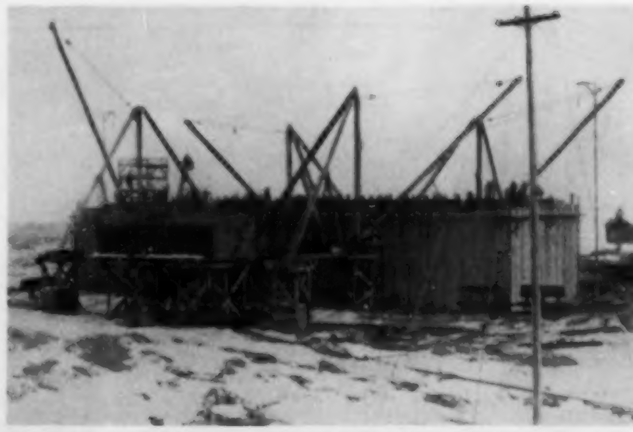


Fig. 5. Timber Caisson Sunk as Drop Shaft
Down 50 Ft in Quicksand for Utah Power and Light Company Installation, Bear Lake, Idaho

For relatively great depths, piers may be built above the ground surface and sunk by excavating the ground beneath them. The piers are built as cylinders or prisms containing chambers open to the ground below (Figs. 5 and 6). In sinking such piers in waterbearing soil, there is frequently a loss of ground around them. This method must therefore be restricted when adjacent structures might be damaged. To minimize this danger, the shafts are frequently kept full of water, and the excavation is made by dredging. However, unless an impervious stratum can be reached, it is often impossible to clean off and level the rock without recourse to divers or to the pneumatic method.

Frequently the friction around sinking piers is greater than the weight of the piers, particularly when the shafts are filled with water. At times this friction amounts to 350 to 500 lb or more per sq ft, and it often becomes necessary to load the piers during the sinking operation. The foundations for the Standard Milling Warehouse in Jersey City, N.J. (Fig. 6), consisted of 114 cylindrical piers, most of which were 7 ft in outside diameter with 5-ft diameter shafts. Many of these piers were sunk as much as 100 ft by dredging through the shafts, but as they had to be belled out at the bottom in heavily water-

Fig. 6. Cylindrical Caissons for Standard Milling Warehouse, Jersey City, N.J.

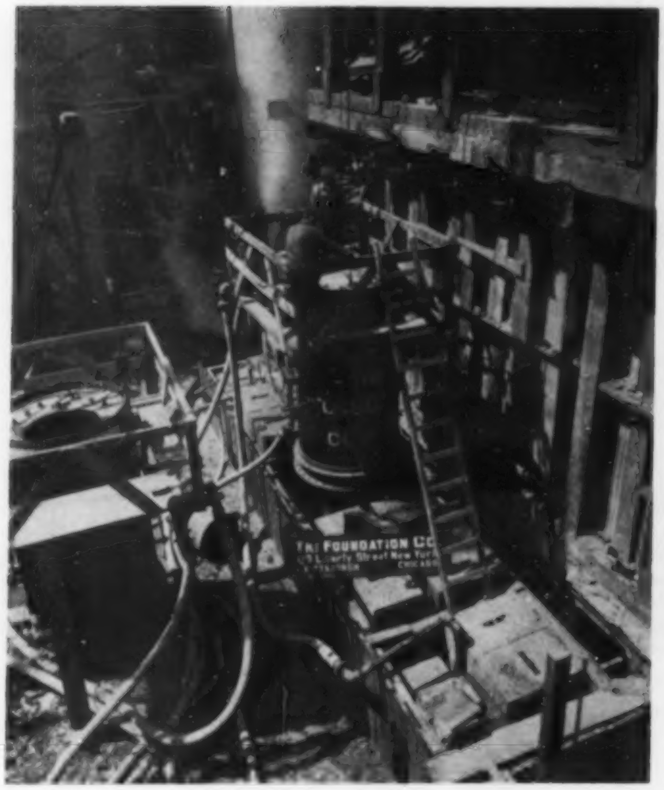


FIG. 7. AIR LOCKS ON PNEUMATIC CAISSONS
Temporary Cast-Iron Weights Force Cylinders Down

bearing ground, the latter part of the work had to be done by the pneumatic method.

Well points—perforated pipes driven into the ground 3 to 5 ft apart horizontally—may be used to drain a foundation in advance of excavation. With suitable pumps the water level can be lowered as much as 20 ft in porous ground. By installing a second or third system of well points, below the first, as the water level is lowered, additional depth may be gained.

The pneumatic method of excavation, illustrated in Fig. 7, has the advantages that danger of damage to adjacent structures is at a minimum and that it may be used through unstable ground, through boulders, or through solid rock. It is limited, however, to a depth of about 115 ft below the water level. Its disadvantage is its cost. The principle employed is the same used in drop shafts except that the chamber at the bottom is closed at the top and filled at all times with compressed air at a pressure sufficient to exclude water or soft ground. The excavation is accomplished by men working in this chamber and access to it is had through air locks mounted on the tops of the shafts. This method is often used in combination with the drop shaft, using the pneumatic procedure only at the bottom in order to reach the rock through water-bearing strata, and to level or bench off the rock surface.

A procedure known as the Powell method can be used when the surface of the bedrock is level and when the ground above does not contain boulders or hardpan. A set of arms, of the diameter of the proposed cylindrical pier and fitted with scarifying tools, is rotated in the ground, reducing the soil to soft mud. The cutting tool sinks as the ground is liquefied. When rock is reached the tool is removed, leaving the mud in place to support the surrounding ground. A steel shell is next lowered and driven through the mud to the rock, and the mud within it is excavated. The shell is then filled with concrete.

The Montee method of sinking a cylindrical foundation pier employs a steel shell of the pier diameter and length. The shell is fitted like a core drill, its bottom edge being provided with hardened steel teeth, and its top closed by a temporary head. It is kept full of water and fitted with water jets at the bottom. The whole is rotated by a motor connected with the head. The motor, gearing, and shell are suspended from a steel frame in such a manner that they can be raised or lowered together. The friction of the ground against the sides of the shell is to a great extent eliminated by an eccentric connection of the driving shaft with the head of the shell and by the helical flow of water from the bottom of the shell and along the sides up to the ground surface. This flow removes a large part of the ground materials enclosed by the sinking shell. The apparatus can cut through large boulders and even into rock. When the rock is reached the head is taken off, the material remaining inside the shell is removed, and the shell is filled with concrete. This method is applicable to conditions in which the boulders are comparatively few and the underlying rock is level. Under such circumstances the rotating shell drills down to this underlying rock in a very short time.

PILE-DRIVING EQUIPMENT

Piles of all types are now usually driven by steam hammers. Single-acting hammers are preferable for wood or concrete piles, and double-acting hammers are frequently used for pipe piles. As compressed air is usually used for cleaning out pipe piles, the driving hammers are often operated by compressed air. The equipment now used for driving wood piles consists of a steam-operated revolving crane mounted on caterpiller treads. The steel leads in which the hammer travels are suspended from the boom of the crane as in the example shown in Fig. 8.

For concrete piles cast in place, the mandrel must be pulled from the ground. As this often subjects the leads to heavy loads, the equipment cannot be mounted on caterpiller treads. Instead, a revolving crane which travels upon rollers on timber sills is used, or the leads and supporting frame are mounted on skids which slide on steel beams.

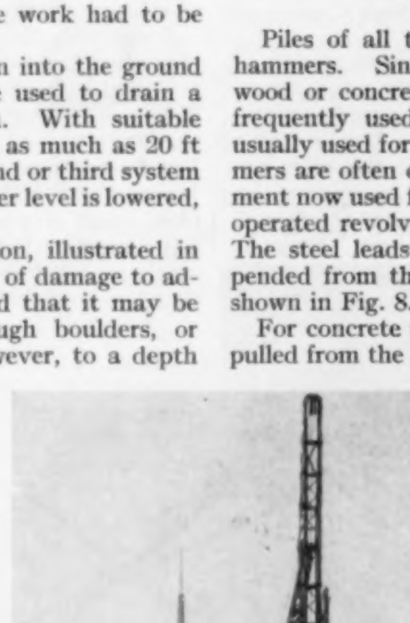


FIG. 8. DRIVING RIG FOR WOOD PILES

Wood sheet piling is driven by hand mauls, or by small pneumatic hammers. Steel piling is usually driven by double-acting steam hammers suspended without leads from the boom of a revolving crane or derrick.

Drop shafts are built up with revolving cranes or derricks and are sunk, sometimes by hand labor with cranes or derricks, but frequently by clamshell or orange-peel buckets operated from cranes or derricks. The same equipment, with the addition of air locks and high- and low-pressure air compressors and receivers, is used in the pneumatic method.

Soil Studies Applied to Highway Problems

Possibilities of New Science Evaluated from Viewpoint of the State Highway Department

From the Program of the Highway Division at the Society's 1940 Spring Meeting

By F. V. Reagel

Engineer of Materials, Missouri State Highway Department, Jefferson City, Mo.

Because few practicing engineers even today can claim the advantage of a thorough academic grounding in engineering soil science, many useful and basic aspects of the work frequently escape assimilation. But the influence of such factors as thickness of moisture film, capillarity, bituminous and cementing binders, or chemical properties has been the object of investigation by agricultural and highway soil men for years, and Mr. Reagel here presents a valuable orientation in the application of this knowledge to stabilization problems.

Soil science, as applied to many of the phases of highway construction and maintenance work, has been of rather recent development. Soils have been studied extensively for many years by the agricultural scientists, and civil engineers have, of necessity, interested themselves in structural foundation problems, but the broader applications now being attempted have been made possible to a great extent by the recent pioneering work of the Public Roads Administration, the U. S. Soil Survey, and other research agencies. Anyone in direct contact with this phase of the work realizes that the present knowledge of fundamentals is still far short of the desired goal, but sufficient progress has been made to permit the development research worker to provide many practical applications.

Most structures rest on soil, either directly or indirectly, and their own weight and their service loads and impacts are transmitted eventually to this supporting medium. Thus the civil engineer has been most often concerned with the bearing power of soil and the correlated problem of settlement. In the highway and drainage fields, however, he must be more and more concerned with soil as a construction material, as in the building of earth dams, levees, and fills. In low and medium-cost road construction, there is also the problem of stabilization to enable soils to better serve their purpose.

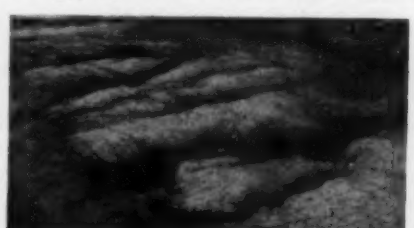
Before proceeding further, we should attempt to define the term "soil." In common engineering usage "Soil comprises the entire envelope of fragmental materials covering the solid rock of the earth's interior" (*Low Dams*, Natural Resources Commission, 1938, page 237). From an agricultural point of view, Morbet defined soil as "the outer layer of the earth's crust, usually unconsolidated, ranging in thickness from a mere film to a maximum of somewhat more than ten feet, which differs from the material beneath it, also usually unconsolidated in color, structure, texture, physical constitution, chemical composition, biological characteristics, etc."

Obviously the foundation engineer is mainly concerned with materials which the geologist would call soil but which the agricultural soil scientist would not. On the other hand, the highway engineer deals mainly with materials which fall within the agricultural definition of soil. This fact suggests the possible use by the highway engineer of the great store of physical and chemical knowledge of soils accumulated in the agricultural and pedological fields. Also, the concept of the pedologist that soil is a material conditioned by, and in the case of maturity, in equilibrium with, the obtaining climatic forces, should serve to remind the highway engineer that the material with which he is dealing is subject to seasonal changes and may possess radically different degrees of stability at different times of the year. Consequently the highway engineer should be chiefly interested in the following two questions: (1) What is the lowest stability which a given soil system may possess as the result of the worst climatic conditions? (2) How can the desired, or the best, all-year stability of the soil system be obtained? The answers to these questions would seem to depend upon the prevailing climate and the susceptibility of the soil to changes in physical properties caused by seasonal changes.

Stated in another manner the engineer really desires to know: (1) Will the soil remain in place under the conditions of use? (2) Will it support the expected loadings? (3) Will it continue to be of the same composition and has it some chemically active constituents? (4) What are the conditions of use as to degree of confinement, range of moisture content, and range, duration, and type of loading (static or moving)?

Broadly speaking the desirable or undesirable characteristics of soil systems depend upon the quantities of water which enter them and the manner and effects of such entrance. Small amounts of moisture, in general, are beneficial as they extend in thin wedges or films promoting cohesion. In larger amounts, moisture produces thicker films which separate and lubricate the mass with consequent loss of stability. Under certain conditions of particle gradation and characteristics, water will pass through the system, while under other conditions it will be tenaciously retained. In general, if the moisture content could be durably stabilized at the correct percentage for the soil system under consideration, the major requirement would be met. The realization of this aim, however, is not at present nearly so simple as the picture.

Naturally, an infinite variety of materials with greatly differing properties may fall within the limits of the term "soil." Whether a particular soil belongs in the category of granular material, silt, clay, or a mixture of these, is determined by an analysis of its particle grading supplemented by so-called standard soil tests. The latter indicate such properties as maximum moisture-holding capacity and elasticity of the soil when wet (liquid limit), cohesion in moist condition (plastic index), its volume change and elasticity when dry (shrinkage limit), its water absorption capacity under field conditions (field moisture equivalent), ease of drainage (vacuum moisture equivalent, centrifuge moisture equivalent), detrimental capillarity (silt content), and friction and cohesion (size composition, shearing strength, plastic index).



Untreated Shoulders Give Way Quickly

Inadequate Grading and Lack of Compaction Evidenced by Severe Water Cutting

PREVENTABLE WITH PROPER BINDER

This classification does not, however, in itself indicate how best to make use of a given soil in order to develop the desired maximum stability—and this is the primary interest of the engineer. Some light is shed on this problem by studies of the effects of compaction. It has been mentioned that this property of soils depends on their cohesion and internal friction. Both these properties obtain their highest values when the constituent particles are most closely in contact. Based on the fact that it is difficult to compact dry soil because of high internal friction and the presence of highly elastic air films, and that excessively thick moisture films prevent soil particles from coming into close contact, Proctor has emphasized the importance of compacting soils at an intermediate optimum moisture content—determined by the well-known Proctor compaction procedure. After compaction, the smallness of the available pores reduces the entrance of excess water, and conditions are created favorable to close contact of particles and maximum stability. This condition, however, will be maintained only at such distance from the surface that temperature variations are small. Temperature and moisture changes in the surface layer of compacted soil may ultimately result in a progressive change of structure and a varying degree of decline in stability. Susceptibility to such changes is determined by a number of soil factors.

The more obvious effects of frost action, such as the so-called frost boils, have been intensively studied. From the work of Casagrande, the tendency of a soil to form ice lenses can be predicted. Kögler has given a general criterion of frost danger which considers not only the soil itself but also the distance of the freezing zone from the ground-water level, the permeability of the soil, and the average duration of freezing temperatures at a specific location. This work on frost action has been extremely valuable but it is probable that the general effect of low temperatures on the structure and stability of soils (and of some other engineering materials), even without the formation of distinct ice lenses, has not yet been sufficiently appreciated or studied.

Through the centuries the farmer has been making use of this method of changing the structure of the soil by exposing it as much as possible to winter temperatures (fall plowing). The resilience of soils in springtime, even if previously compacted, is a point in evidence. At the present state of knowledge of soils as related to highway engineering, it appears that one of the most fertile fields for research lies in the determination of the physical or chemical factors which determine the susceptibility of the soil to structural and stability changes caused by temperature. It is this seasonal change in stability which has prevented the highway engineer from deriving the maximum benefits from the great theoretical advances in pressure distribution and in soil bearing power, and which has forced him to rely on empirical or semi-empirical relationships.

Treatment of a soil to induce maximum all-season stability is called "soil stabilization." This treatment may be (1) mechanical, as illustrated by the Proctor method; (2) physical, as in the blending of different soils to obtain a mixture of optimum characteristics, bituminous binding of sand, etc.; or (3) physico-chemical or chemical, such as bituminous waterproofing of cohesive soils, soil hardening by means of portland cement, and hardening by means of reversible silicates (Joosten process).

The principles underlying the first two methods have already been briefly mentioned. As the name suggests, physico-chemical and chemical phenomena play an important part in the third type of stabilization. The physico-chemical factors of importance in bituminous stabilization have been discussed in the *Proceedings* of the Asphalt Paving Technologists (Chicago, 1940) where it is demonstrated that the effects of bituminous stabilization depend not only on the physical and chemical properties of the bitumen used, but also on the chemical composition and physical structure of the soil; the type and amount of exchange ions present in the soil; and the presence in the soil of hydrophilic or hydrophobic films of organic matter.

Preliminary studies indicate that the same factors may also be of importance in soil-hardening by portland cement. An extensive investigation of this phase is under way in our laboratories. It would seem worth mentioning that chemical information on soils has been collected and organized for many years by the U.S. Soil Survey and related agencies and is available for the asking.

The determination of the physical properties of soils of definite chemical character has brought out the fact that these properties are functions not only of the relative amounts of the different size fractions present, but also to a considerable extent of the surface-chemical character of the soil constituents. It has been shown that the results of the standard subgrade soil tests can be changed considerably by adding to a soil small amounts of various chemical elements or compounds. Since the soil constants measured are functions of the friction and cohesion factors obtained in the soil, it can be stated that the friction and cohesion in soil are dependent on the chemical nature of the soil as well as on the size composition. The significance of this statement is considerable.

PHYSICAL MECHANISM OF SOIL STABILITY

In theoretical equations concerning the stability of earth structures the character of a specific soil is taken into account by using its "friction" and "cohesion" values. At the same time it is known that, in the case of cohesive soils, the terms "friction" and "cohesion" do not possess a fundamental, well-defined meaning. This fact may be only of small importance if the soil is outside the zone of seasonal change. But if the soil is within this zone then it is of primary importance to know: (1) the real physical meaning of the terms "friction" and "cohesion" in cohesive soils, or to be able to substitute for these terms others which do possess a definite physical meaning, and (2) the correlation of stability changes of soils with changing weather conditions.

In other words, it will become increasingly important for the highway engineer to have a thorough understanding of the physical mechanism of soil stability, as it already seems apparent that changing conditions will require that more specific attention be directed toward soil handling and treatment, and the old methods of "cut and try," "cut off the excess," "splice the remainder," and "replace the settlement" will no longer suffice.

At the present time, it seems that this understanding can only be obtained by a patient study of the factors at work in soil-water systems and their relation to such complex phenomena as cohesion and friction. The wider application of soil science, however, has introduced a new condition which may be overlooked. Where formerly foundation problems were generally confined to a restricted area, now the construction features carry forward over miles of terrain, intercepting many and varying layers, so that general rules are not applicable. Each case is a variety of special conditions which must be interpreted and handled accordingly.

It is evident that the highway engineer needs a much more detailed picture for the stability of soils than the foundation engineer or the designer of earth dams and retaining walls. This picture must enable the highway engineer to cope with a wide variety of conditions of material and drainage and to explain and predict the effect of the seasons on his soil structure. It is the function of the soils scientist to form and interpret this picture.

THREE KINDS OF SUBGRADE STABILIZATION

It may be of interest, before concluding, to very briefly describe in terms of usage, that most recent adaptation of highway soil science, subgrade stabilization, and to list some of the specific activities and problems of the soil scientist in this field. Based on the materials used, there are three general types of subgrade stabilization: (1) clay gravel, (2) bituminous, and (3) soil cement.

The first implies the production of stability by appropriate grading of the aggregate and by utilizing the cementing properties of the clay binder. The grading of the aggregate is definitely the major phase. The gradation zone established by practice could be based on the familiar Fuller's density curve. In theory, the clay binder should hold the mass stable when dry, and the inherent friction of the aggregate should take over the burden when excess moisture softens the clay binder. Chemicals, such as calcium and sodium chlorides, may be added to hold some moisture in the mass during dry weather.

This type has the advantages of low cost and flexibility in application to either base or base and surface combined. On the other hand, it may permit a gradual reduction in thickness through the encroachment of the soil below during adverse seasonal conditions.

The second type of stabilization is based on the idea that the waterproofing of the mass by the addition of small percentages of bituminous materials will prevent accumulation of moisture, and thus eliminate plasticity while retaining the optimum condition for stability.

Various types of bituminous material are successfully used. Quantities generally range from 7 to 8% by weight of the soil phase of the mass. This results in very thin films sometimes approximating a stain in appearance. The soil phase is definitely the major phase in most cases, the percentage of aggregate being adjusted to the point of economy. The application of surface oil to earth roads is a first cousin to this procedure, the effects of plasticity being minimized by the thinness of the treated layer.

In general, the bituminous procedure is used for base construction only, because the resulting mass is rather friable. It is adapted to combination with very thin surface layers as the entire structure is waterproofed and automatically primed. It has the advantage of comparative permanence and can be used in areas where aggregates are not economically available. A possible disadvantage is its loss of stability if an excess of bituminous material is present.

Stabilization of the third type, soil-cement, does not normally require the addition of aggregate, but it is economically selective as to the soils with which it may be used, for the percentage of cement required increases rapidly with the decrease in soil particle size. In current practice, the range of cement content is generally about 6 to 14% by weight of the soil mass.

The method is useful where economical aggregates may be lacking and produces a surface that tends to resist edge failure. It is, however, somewhat difficult to secure the priming needed to bind the thin layers of protective surface to the material, and thicker layers of stable surfacing may be required.

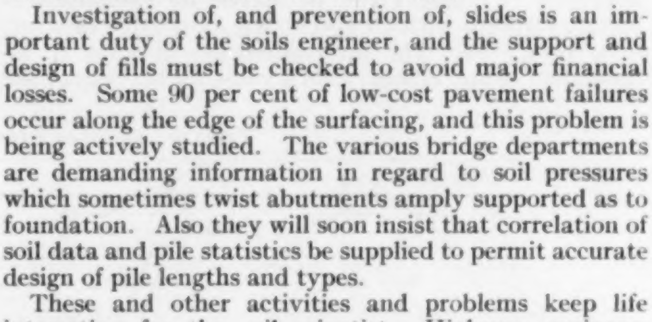
The theory involved in the use of cement as a soil binder is not as yet so clearly understood as might be desired. Seemingly, rigid slabs are obtained, and waterproofing results from the crystalline and silica jell masses that are formed in the voids of the soil by the hydration of the cement particles.

All three types are passing or have passed beyond the purely experimental stage and, with increased knowledge and improved technique, should soon take their place as usable procedures in the low-cost construction field for both highway and airport improvements.

Many highway departments, as a matter of routine, now conduct detailed soil surveys prior to drawing the plans for any improvement. The entire soil profile is surveyed, sampled, and tested at intervals dictated by conditions. Corrective measures resulting from such surveys include special drainage features; removal and replacement in the case of soils of too poor characteristics, or changes in grade line for the avoidance of such material; provision for insulating layers in case of frost boil conditions; mixing and conditioning of soils to improve supporting value; and development of information bearing on proper thickness for pavements. No accurate gage as to pavement thickness which will permit the tailor-making of pavements to fit subgrade conditions is available for any type of pavement, although literally millions of dollars could be saved for additional development if this information were available.

Investigation of, and prevention of, slides is an important duty of the soils engineer, and the support and design of fills must be checked to avoid major financial losses. Some 90 per cent of low-cost pavement failures occur along the edge of the surfacing, and this problem is being actively studied. The various bridge departments are demanding information in regard to soil pressures which sometimes twist abutments amply supported as to foundation. Also they will soon insist that correlation of soil data and pile statistics be supplied to permit accurate design of pile lengths and types.

These and other activities and problems keep life interesting for the soil scientist. Highway engineers may expect to become better and better acquainted with him as time marches on.



GRASS BINDER OR BITUMINOUS WATERPROOFING WOULD CORRECT IN PART

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Some Applications of the Method of Tension Coefficients

By H. J. KESNER, M. AM. SOC. C.E.

PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF NEBRASKA, LINCOLN, NEBR.

RECENT English textbooks, notably Southwell's *Theory of Elasticity* and Pippard and Baker's *Analysis of Engineering Structures*, have described a general method of analysis for statically determinate space frames known as the "method of tension coefficients." Professor Pippard has also presented a brief outline of the method in an article in CIVIL ENGINEERING ("Stress Analysis for Space Frames," December 1935, page 799), but the method does not seem to be included in the standard texts used most frequently in the United States.

After some experimentation with it the writer feels that its value lies as much in the systematizing of the necessary computations as in the introduction of novel concepts.

To illustrate the application of the method, therefore, a solution has been prepared for the space frame shown in the paper by F. H. Constant, M. Am. Soc. C.E., "Stresses in Space Structures" (TRANSACTIONS of the Society, Vol. 100, 1935, page 928). The notation is that developed in Professor Pippard's paper already referred to. To state the equations requires only a knowledge of the principles of elementary statics. To solve them only elementary algebra need be employed.

Figure 1 shows the frame in plan and elevation. Table I shows the resolution equations. Table II shows values of the tension coefficients, stresses, and reactions. The equations of Table I can be solved by computers of ordinary ability without specialized knowledge of structural principles. The three equations at joint E, independent of any others, yield a value for t_{13}. Equations at joint F then yield values of t_6, t_7, and t_{14}. Equations at joints G and H are readily solved. With t_{16} known, the solution of joint E for unknowns t_5 and t_{12} is readily completed. Remaining joints are then solved in the order C, D, B, A. A complete solution is made from the joint equations, and the resolution and moment equations of statics applied to the external forces are available for checks.

TABLE II. COEFFICIENTS AND STRESSES OBTAINED FROM EQUATIONS OF TABLE I

MEMBER	TENSION COEF., t	LENGTH	STRESS
1	+ 7.65	26	+ 199
2	+30.60	26	+ 796
3	+48.28	26	+1255
4	+ 4.95	26	+ 129
5	+62.93	22.98	+1446
6	− 7.03	28.07	− 197
7	−42.97	22.98	− 987
8	+18.10	28.07	+ 508
9	−53.45	22.98	−1228
10	−45.97	28.07	−1290
11	+45.97	22.98	+1056
12	−27.58	28.07	− 774
13	−21.72	10	− 217
14	−40.00	10	− 400
15	+32.92	10	+ 329
16	+50.00	10	+ 500

$V_A = -1118$ $V_B = +497.4$ $V_C = +1988.6$ $V_D = -367.8.$
$H_1 = +575.7$ $H_2 = +575.7$ $H_B = +777.4$ $H_D = +1402$

As a further exercise in the application of this method, the writer has solved the frame described by Dean L. E. Grinter, M. Am. Soc. C.E., in his discussion of Professor Constant's paper. Figure 2 shows the plan and elevation of the frame. Table III shows the joint equations, all

TABLE I. EQUATIONS FOR THE SPACE FRAME OF FIG. 1

JOINT		EQUATIONS
A	x	$26t_1 + 8t_5 + 18t_6 - H_1 = 0$
	y	$+26t_4 + 8t_5 + 8t_6 - H_2 = 0$
	z	$+20t_5 + 20t_6 + V_A = 0$
B	x	$-26t_1 - 8t_7 - 8t_8 = 0$
	y	$26t_2 + 8t_7 + 18t_8 - H_B = 0$
	z	$20t_7 + 20t_8 + V_B = 0$
C	x	$-26t_3 - 8t_9 - 18t_{10} = 0$
	y	$-26t_2 - 8t_9 - 8t_{10} = 0$
	z	$20t_9 + 20t_{10} + V_C = 0$
D	x	$26t_3 + 8t_{11} + 8t_{12} - H_D = 0$
	y	$-26t_4 - 8t_{11} - 18t_{12} = 0$
	z	$20t_{11} + 20t_{12} + V_D = 0$
E	x	$-8t_5 - 8t_{12} + 10t_{13} + 500 = 0$
	y	$-8t_5 + 18t_{12} + 10t_{16} + 500 = 0$
	z	$-20t_5 - 20t_{12} + 707 = 0$
F	x	$-18t_6 + 8t_7 - 10t_{13} = 0$
	y	$-8t_6 - 8t_7 + 10t_{14} = 0$
	z	$-20t_6 - 20t_7 - 1000 = 0$
G	x	$+8t_8 + 8t_9 - 10t_{15} + 612 = 0$
	y	$-18t_8 + 8t_9 - 10t_{14} + 353.5 = 0$
	z	$-20t_8 - 20t_9 - 707 = 0$
H	x	$+18t_{10} - 8t_{11} + 10t_{15} + 866 = 0$
	y	$+8t_{10} + 8t_{11} - 10t_{16} + 500 = 0$
	z	$-20t_{10} - 20t_{11} = 0$

TABLE III. EQUATIONS FOR THE SPACE FRAME OF FIG. 2

Joint		Equations
A	x	$30t_1 + 10t_{10} + 15t_{11} - R_3 = 0$
	y	$30t_4 + 15t_{10} + 10t_{11} = 0$
	z	$+30t_{10} + 30t_{11} + R_4 = 0$
B	x	$-30t_1 - 15t_{12} - 10t_{13} = 0$
	y	$+30t_2 + 10t_{12} + 15t_{13} + R_6 = 0$
	z	$+30t_{12} + 30t_{13} + R_5 = 0$
C	x	$-30t_3 - 10t_{14} - 15t_{15} = 0$
	y	$-30t_2 - 15t_{14} - 10t_{15} = 0$
	z	$+30t_{14} + 30t_{15} + R_7 = 0$
D	x	$+30t_3 + 15t_{16} + 10t_{17} + R_1 = 0$
	y	$-30t_4 - 10t_{16} - 15t_{17} = 0$
	z	$+30t_{16} + 30t_{17} + R_2 = 0$
E	x	$+5t_5 + 5t_8 - 10t_{10} - 10t_{17} + 1000 = 0$
	y	$-5t_5 + 5t_8 - 15t_{10} + 15t_{17} - 3000 = 0$
	z	$-30t_{10} - 30t_{17} - 2000 = 0$
F	x	$-5t_5 + 5t_6 - 15t_{11} + 15t_{12} = 0$
	y	$+5t_5 + 5t_6 + 10t_9 - 10t_{11} - 10t_{12} = 0$
	z	$-30t_{11} - 30t_{12} = 0$
G	x	$-5t_6 - 5t_7 + 10t_{13} + 10t_{14} = 0$
	y	$-5t_6 + 5t_7 - 15t_{13} + 15t_{14} = 0$
	z	$-30t_{13} - 30t_{14} = 0$
H	x	$+5t_7 - 5t_8 + 15t_{15} - 15t_{16} = 0$
	y	$-5t_7 - 5t_8 - 10t_9 + 10t_{15} + 10t_{16} = 0$
	z	$-30t_{15} - 30t_{16} = 0$

TABLE IV. INTERMEDIATE DEVELOPMENT OF EQUATIONS OF TABLE III

$+30t_1 + 10t_{10} - 15t_{12} - 2{,}500 = 0$
$+30t_4 + 15t_{10} - 10t_{12} = 0$
$+30t_{10} - 30t_{12} - R_5 + 4{,}000 = 0$
$-30t_1 - 15t_{12} + 10t_{14} = 0$
$+30t_2 + 10t_{12} - 15t_{14} + 3{,}000 = 0$
$+30t_{12} - 30t_{14} + R_5 = 0$
$-30t_3 - 10t_{14} - 15t_{15} = 0$
$-30t_2 - 15t_{14} - 10t_{15} = 0$
$+30t_{14} + 30t_{15} - R_5 + 1{,}666.7 = 0$

TABLE V. COEFFICIENTS AND STRESSES OBTAINED FROM EQUATIONS OF TABLES III AND IV

Member	Tension Coef., t	Length	Stress	Reactions
1	+ 63.88	30	+1,916	$R_1 = +1{,}500$
2	− 40.74	30	−1,222	$R_2 = +766.7$
3	− 36.11	30	−1,083	$R_3 = +2{,}500$
4	+ 7.41	30	+ 222	$R_4 = -433.3$
5	−346.67	7.07	−2,451	$R_5 = +4{,}433.3$
6	+180.00	7.07	+1,273	$R_6 = +3{,}000$
7	−180.00	7.07	−1,273	$R_7 = -2{,}766.7$
8	+ 13.33	7.07	+ 94	
9	+ 83.33	10	+ 833	
10	− 73.33	35	−2,567	
11	+ 87.77	35	+3,072	
12	− 87.77	35	−3,072	
13	− 60.00	35	−2,100	
14	+ 60.00	35	+2,100	
15	+ 32.22	35	+1,128	
16	− 32.22	35	−1,128	
17	+ 6.67	35	+ 233	

written before the solution of stresses is undertaken. Any legitimate method of solving these equations will of course lead to the values of the unknowns—in this case 17 tension coefficients and 7 reaction components. It seems simplest here to derive the reaction components by applying first the three translation equations and three rotation equations for the frame as a whole. However, there are 7 components and only 6 equations, so that one component—R_5 in this instance—remains unknown. Values thus obtained are $R_1 = +1{,}500$, $R_2 = R_5 - 3{,}666.7$, $R_3 = +2{,}500$, $R_4 = 4{,}000 - R_5$, $R_6 = +3{,}000$, $R_7 = 1{,}666.7 - R_5$.

The original equations show $t_{11} = -t_{12}$, $t_{13} = -t_{14}$, $t_{15} = -t_{16}$. The first nine equations may therefore be rewritten to contain only nine unknowns. All reaction components except R_5 and t_{11}, t_{13}, and t_{16} are eliminated. The first nine equations then take the form given in Table IV.

The solution of these equations is neither difficult nor lengthy. With these first nine unknowns evaluated, joints A, B, and C are completely solved from the original equations of Table III. The remaining joints then follow in the order G, H, F, E, D. All values are recorded in Table V. Each stress is then obtained as the product of a tension coefficient and a length.

While the method of tension coefficients is particularly useful in the solution of space frames, it can be used without modification for cases in which all members lie in a single plane.

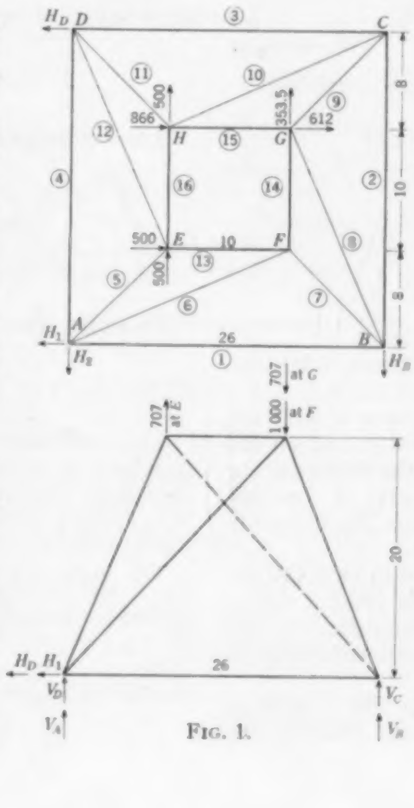


FIG. 1.

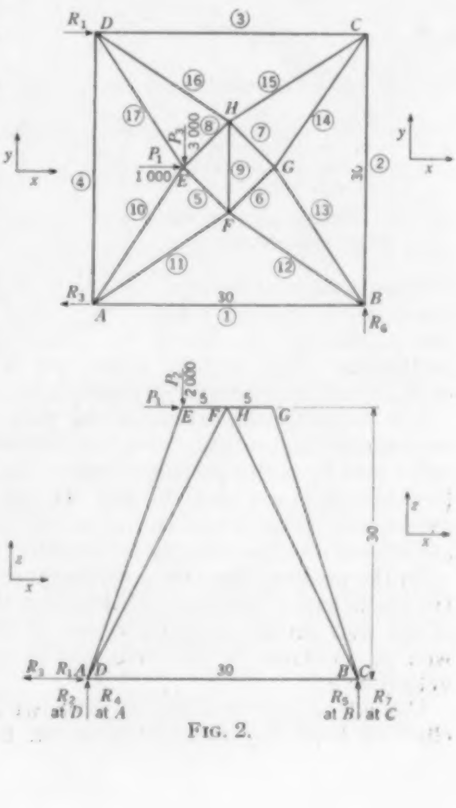


FIG. 2.

Theoretical Discharge Coefficients for a Weir of Ogee Profile

By I. NELIDOV, ASSOC. M. AM. SOC. C.E.

SENIOR ENGINEER OF HYDRAULIC STRUCTURE DESIGN, STATE DIVISION OF WATER RESOURCES, SACRAMENTO, CALIF.

AMONG the first requirements for the design or analysis of a spillway are the depth and energy content at the weir crest. These quantities are needed before it is possible to proceed with computations for water level in the spillway below the weir. Usually, for instance with a rectangular weir, a coefficient is assumed from the shape of the weir profile, and from this, with the given head, the discharge may be computed. It might seem at first that the problem would be solved by assuming a depth at the crest equal to the critical depth computed from the formula $d_c = \sqrt[3]{\frac{q^2}{g}}$, where q is the discharge per linear foot of weir. However, the energy content found at the crest of the weir by adding this critical depth to the critical velocity head does not check the head on the weir.

To illustrate, consider a rectangular weir of ogee profile with a head, $H = 5.0$ ft, and a coefficient of discharge, $C = 3.5$. The discharge per linear foot of this weir will be $q = 3.5 \times 5.0^{3/2} = 39.2$ cu ft per sec per ft. Considering no losses, the critical depth is $d_c = \frac{2}{3}H = 3.33$ ft. The critical velocity $V_c = 11.75$ ft per sec, and the critical velocity head, $h_{vc} = 2.15$ ft. Then the energy content will be $d_c + h_{vc} = 3.33 + 2.15 = 5.48$ ft, which is not equal to $H = 5.0$ ft. If losses were added, then the discrepancy would be still greater because d_c would be smaller; and the velocity V_c and the head h_{vc} would be greater.

The cause of this discrepancy lies in the fact that the coefficient $C = 3.5$ is possible to obtain only when the flow over the weir is curvilinear, while the limits for the coefficient C for a rectangular weir, without losses, are between 3.09 and 4.18, as will be subsequently shown.

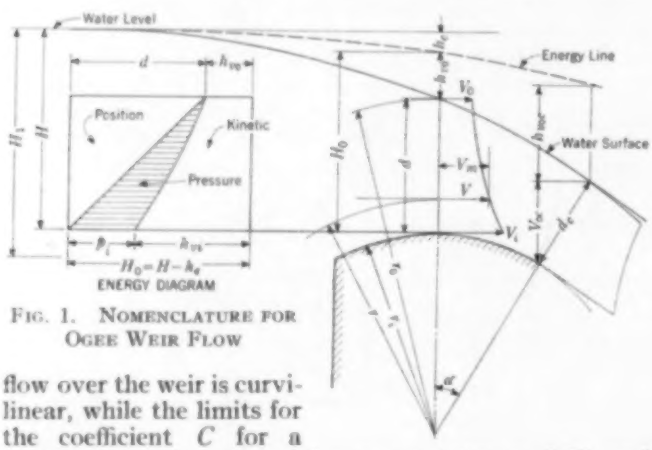


FIG. 1. NOMENCLATURE FOR OGEE WEIR FLOW

The limiting conditions of the flow over a weir are represented on one side by a control section and on the other side by a sharp-crested weir. In the first case the flow filaments are straight and the velocity is constant over the cross section. In the second case the filaments are curved and the velocity is variable.

In the ensuing discussion derivations will be given for the coefficient of discharge C, depth on the crest d, radius of the weir profile r_i, and pressure on the surface of the weir p_i, in terms of the coefficient of non-uniformity of velocities k.

Consider a weir of radius r_i, as shown in Fig. 1, with an effective head H_0, obtained from the total head on the weir H by deducting entrance losses h_e. Denote $n = \frac{p_i}{d}$, a ratio of the pressure on the weir to depth. For a control section, $n = 1.0$, since the pressure is hydrostatic. For an aerated sharp-crested weir, $n = 0.0$, the pressure on the lower nappe being atmospheric. If the ogee weir has the same radius as the lower nappe of the sharp-crested weir, $n = 0.0$ likewise.

The derivations will follow in general the same line of thought presented by B. A. Bakhmeteff, M. Am. Soc. C.E., in the treatment of sharp-crested weirs in his *Hydraulics* (*Hydraulics*, Part II, p. 102, edition of 1913 in Russian). The original theory was by Boussinesq.

By writing $k = V_0/V_1$, a ratio of the velocity at the free water surface to that on the surface of the weir, we may express the depth on the weir, d, and its radius r_i in terms of k and H_0.

Thus
$$k = \frac{V_0}{V_1} = \sqrt{\frac{2g(H_0 - d)}{2g(H_0 - p_i)}} \qquad \text{(1)}$$

where H_0 is the effective head.

Since $p_i = nd$, the depth d is found from Eq. 1 as follows:

$$d = H_0 \frac{1 - k^2}{1 - nk^2} \qquad \text{(2)}$$

Because in an ideal curvilinear flow $\frac{V_0}{V_i} = \frac{r_i}{r_i + d}$, we find, by using Eq. 1, that

$$r_i = \frac{k}{1 - k} d = H_0 \frac{k(1 + k)}{1 - nk^2} \qquad \text{(3)}$$

Any velocity within the depth d is $V = \frac{V_i r_i}{r}$, which after substituting V_i and r_i from Eqs. 1 and 3, becomes

$$V = \sqrt{2g}\, \frac{H_0^{3/2}}{r} \frac{k(1 + k)(1 - n)^{1/2}}{(1 - nk^2)^{3/2}} \qquad \text{(4)}$$

The discharge is then

$$q = \int_{r_i}^{r_0} V\,dr = \sqrt{2g}\, H_0^{3/2} k(1 + k) \frac{(1 - n)^{1/2}}{(1 - nk^2)^{3/2}} \int_{r_i}^{r_0} \frac{dr}{r}$$
$$= \sqrt{2g}\, H_0^{3/2}\, k(1 + k) \log_e \frac{1}{k} \frac{(1 - n)^{1/2}}{(1 - nk^2)^{3/2}} \qquad \text{(5)}$$

From Eq. 5 the coefficient of discharge is

$$C_0 = \sqrt{2g}\, k(1 + k) \log_e \frac{1}{k} \frac{(1 - n)^{1/2}}{(1 - nk^2)^{3/2}} \qquad \text{(6)}$$

This coefficient is referred to the head H_0. The solution for k in terms of n is obtained on the principle of the maximum discharge or maximum coefficient of discharge, in a manner similar to that used by Boussinesq for the sharp-crested weir.

The equation for determination of k in terms of assumed n is then $\frac{dC_0}{dk} = 0$, or

$$(1 + 2k) \log_e \frac{1}{k} - (1 + k) + k^2(1 + k) \log_e \frac{1}{k} \frac{3n}{1 - nk^2} = 0 \qquad \text{(7)}$$

It is simpler to determine n in terms of k, or

$$n = \frac{A}{k^2A - B} \quad \ldots\ldots\ldots\ldots\ldots (8)$$

where $A = (1 + 2k) \log_e \frac{1}{k} - (1 + k)$, and $B = 3k^2(1 + k) \log_e \frac{1}{k}$.

The limits for k are as follows. For a sharp-crested weir or ogee weir fitting its lower nappe, $k = 0.4685$, as obtained from Eq. 7, with $n = 0$. For a control section, $k = 1.0$. Table I gives the values of n, $\frac{d}{H_0}$, $\frac{r_i}{H_0}$, and C_0 for different values of k. The values of this table are plotted in Fig. 2.

It might be noted that the coefficient of discharge C, expressed in terms of the total head H, will be smaller than C_0, or

$$C = C_0\left(\frac{H_0}{H}\right)^{3/2} = C_0(1 - p)^{3/2} \quad \ldots\ldots (9)$$

where $p = \frac{h_e}{H}$, a ratio of the entrance loss to total head.

TABLE I. VARIOUS QUANTITIES FOR DIFFERENT VALUES OF k

k	n	$\frac{d}{H_0}$	$\frac{r_i}{H_0}$	C_0
0.4685	0.000	0.780	0.688	4.183
0.5	0.141	0.778	0.778	4.078
0.6	0.452	0.763	1.146	3.800
0.7	0.647	0.747	1.742	3.584
0.8	0.786	0.724	2.897	3.403
0.9	0.898	0.697	6.280	3.241
1.0	1.000	0.667	∞	3.089

Quantitatively the entrance loss h_e should be assumed. While there are no data as what it is for a control section, and it may be taken as zero, for a sharp-crested weir it can be determined from the value of 3.333 for a known observed coefficient C. Since the head on a sharp-crested weir corresponding to this coefficient is $H_1 = H\frac{1.0}{1.0 - 0.11} = 1.12H$, the coefficient of discharge without losses should be

$$C = 4.183\left(\frac{1.00}{1.12}\right)^{3/2} = 3.52.$$

The losses will be found from the equation, $q = 3.52\,(H_1 - h_e)^{3/2} = 3.33H_1^{3/2}$, from which $\frac{h_e}{H_1} = 0.037$, which is 3.7% of head H_1, or 4.2% of head H.

The position of the critical depth is fixed downstream from the highest point of the weir, by an angle α. Since

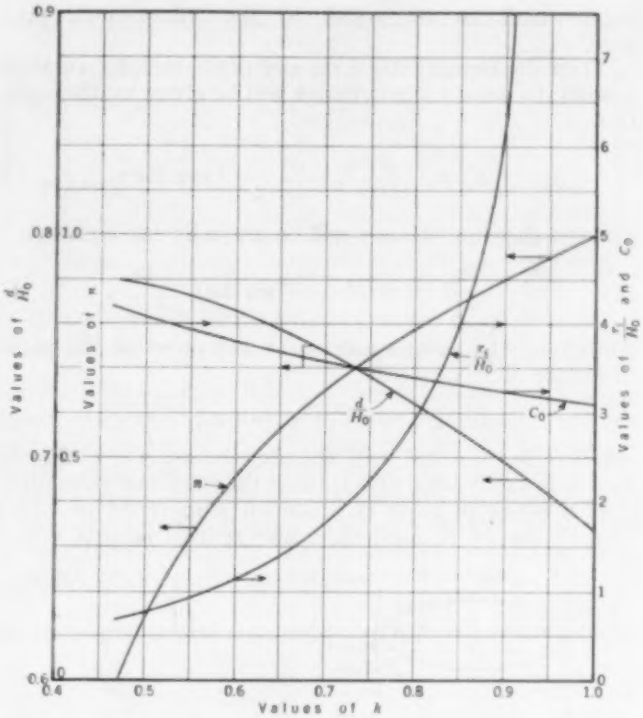


FIG. 2. CHART FOR OBTAINING DEPTH AND DISCHARGE OVER A WEIR OF KNOWN RADIUS AND HEAD

it does not affect the previous discussion, further reference need be made only to the discussion by B. A. Bakhmeteff of the paper, "Tests of Broad-Crested Weirs," by J. G. Woodburn, Assoc. M. Am. Soc. C.E., (TRANSACTIONS, Vol. 96, 1932, p. 423). However, the effect of the inclination of the filaments to the horizontal and the increase in radius should be taken into account.

Example: Given a head on the weir, $H = 5.0$ ft, and a radius of the crest, $r_i = 10.0$ ft. Required to find the depth and discharge over the weir. To solve find the ratio

$$\frac{r_i}{H} = \frac{10.0}{5.0} = 2.$$

With this ratio we obtain from the curves in Fig. 2, $k = 0.748$, $n = 0.690$, $\frac{d}{H_0} = 0.741$, and $C_0 = 3.53$. Assuming a 2% loss on the weir, we will have $H_0 = 0.98 \times 5.0 = 4.9$ ft.

Therefore $d = 0.741 \times 4.9 = 3.63$ ft, $h_{v_0} = 4.90 - 3.63 = 1.27$ ft, $C = 3.53\,(1 - 0.02)^{3/2} = 3.42$, and $q = 3.42 \times 5.0^{3/2} = 38.3$ cu ft per sec per ft.

Graphic Procedure for Interpreting Triaxial Compression Tests

By FREDERICK C. SMITH, ASSOC. M. AM. SOC. C.E.

and ROBERT Q. BROWN

RESPECTIVELY ASSISTANT PROFESSOR OF CIVIL ENGINEERING AND ASSISTANT PROFESSOR OF GENERAL ENGINEERING, UNIVERSITY OF WASHINGTON, SEATTLE, WASH.

THE usual graphic analysis of triaxial test data by means of Mohr's circle is sometimes subject to difficulty in the selection of a common tangent for the different circles of stress. An alternative graphic procedure intended to provide a more convenient interpretation of such data is presented here.

In the analysis of the results obtained by the triaxial compression tests on a cylinder composed of homogeneous material, the cylinder is treated as though it were subjected to biaxial combined stress (Fig. 1). The major principal stress σ_1, is assumed equal to the major unit pressure, p_v, and the minor principal stress, σ_2,

is assumed to be equal to the minor unit pressure, p_h.

Then the normal stress on any plane making an angle α with the axis of the cylinder will be given by the equation

$$\sigma_n = \frac{\sigma_1 + \sigma_2}{2} - \frac{\sigma_1 - \sigma_2}{2} \cos 2\alpha \ldots\ldots (1)$$

and the shearing stress τ will be given by the equation

$$\tau = \frac{\sigma_1 - \sigma_2}{2} \sin 2\alpha \quad \ldots\ldots\ldots\ldots (2)$$

At failure, the shearing stress at any point on the plane of failure is

$$\tau = C + \sigma_n \tan \phi$$

where τ is the total unit shearing resistance, C the cohesion per unit area, and $\sigma_n \tan \phi$ the frictional resistance.

If a series of tests is made on a material to which Mohr's theory is applicable, and several related values

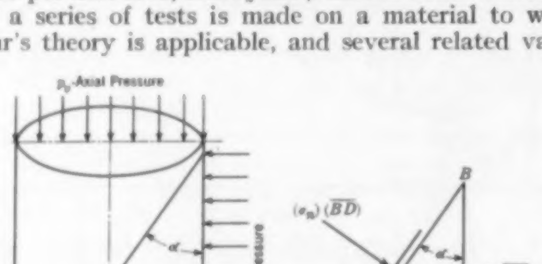


Fig. 1. Loading and Stresses

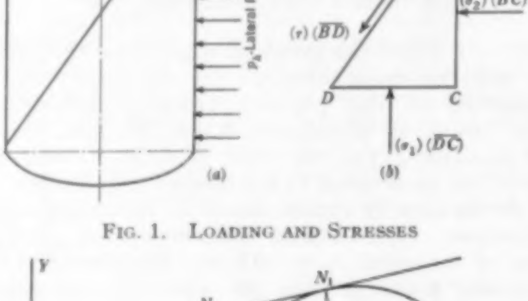


Fig. 2. The Mohr Stress Circles

of σ_1 and σ_2 at failure are obtained, the values of C and $\tan \phi$ can be found by means of Mohr's diagram, Fig. 2.

In this figure, the distance $\overline{NM}$, is $\frac{\sigma_1 - \sigma_2}{2} \sin 2\alpha$, and the distance $\overline{OM}$ is $\frac{\sigma_1 + \sigma_2}{2} - \left(\frac{\sigma_1 - \sigma_2}{2}\right) \cos 2\alpha$. These values, as shown in Eqs. 1 and 2, are the normal stress and the shearing stress, respectively, on a plane making an angle α with the long axis of the specimen. The line $\overline{NN'}$ represents the expression $C + \sigma_n \tan \phi$, the shearing resistance of the material.

Failure must occur on that plane on which the shearing resistance equals the shearing stress, therefore, if σ_2', σ_1'', and σ_1' and σ_1'' are the principal stresses at failure, one point on each of the principal circles must fall on the line $\overline{NN'}$. A detailed explanation of this solution was given on pages 198–200 of *Public Roads* for December 1938.

In practice, when a series of tests is performed on a material to determine C and $\tan \phi$, the principal circles are drawn for each of the related values of σ_1 and σ_2; the common tangent is drawn; and C and $\tan \phi$ are scaled from the graph.

When a number of principal circles based on experimental values are drawn, no one line will be tangent to all the principal circles, and it is difficult to determine the most probable values of C and $\tan \phi$. This is especially true if the experimental values fall within a narrow range. This difficulty is illustrated by the circles in Fig. 3, which is based on the data obtained from

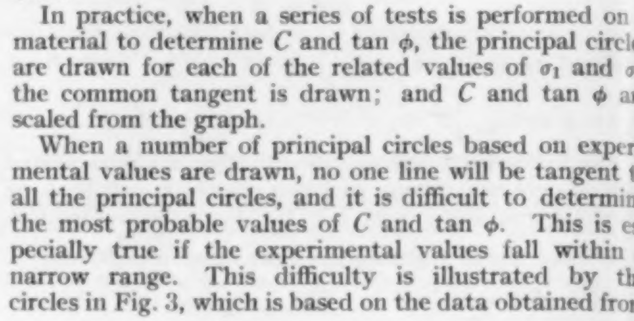


Fig. 3. Typical Test Data
Common Tangent Difficult to Select

tests made by the writers on six cement mortar cylinders.

The writers have been conducting a series of tests on cement mortar cylinders of different mixes. For each mix nine cylinders were tested and nine principal circles drawn. Because of the difficulty just mentioned, the writers felt the need for a new method of analysis of the data, and with the assistance of Z. W. Birnbaum, assistant professor of mathematics at the University of Washington, developed the following:

If Eqs. 1, 2, and 3 are combined, the following equation expresses the condition at failure:

$$\left(\frac{\sigma_1 - \sigma_2}{2}\right) \sin 2\alpha = C + \tan \phi \left[\left(\frac{\sigma_1 + \sigma_2}{2}\right) - \left(\frac{\sigma_1 - \sigma_2}{2}\right) \cos 2\alpha\right] \ldots (4)$$

An inspection of Fig. 2 shows that at failure

$$2\alpha = 90° - \phi \ldots\ldots\ldots\ldots (5)$$

Therefore for the conditions at failure, Eq. 4 can be written,

$$\left(\frac{\sigma_1 - \sigma_2}{2}\right) \cos \phi = C + \tan \phi \left[\left(\frac{\sigma_1 + \sigma_2}{2}\right) - \left(\frac{\sigma_1 - \sigma_2}{2}\right) \sin \phi\right]$$

This reduces to

$$\sigma_1 = 2C\left(\frac{\cos \phi}{1 - \sin \phi}\right) + \sigma_2\left(\frac{1 + \sin \phi}{1 - \sin \phi}\right) \ldots (6)$$

$$\frac{\cos \phi}{1 - \sin \phi} = \tan \phi + \sqrt{1 + \tan^2 \phi}$$

and

$$\frac{1 + \sin \phi}{1 - \sin \phi} = \left(\tan \phi + \sqrt{1 + \tan^2 \phi}\right)^2$$

Introducing the abbreviation,

$$\gamma = \tan \phi + \sqrt{1 + \tan^2 \phi}$$

Equation 6 becomes

$$\sigma_1 = 2C\gamma + \gamma^2\sigma_2 \ldots\ldots\ldots\ldots (7)$$

This is a linear equation of the form, $y = b + mx$, where b is the y intercept, and m the slope of the line representing the equation.

If a series of experiments is made and for each experiment σ_1 is plotted against σ_2, then the slope of the straight lines through the points will equal γ^2; and C, the shearing strength or cohesion of the material, will equal the y intercept divided by 2γ. Further, tan ϕ will equal $\dfrac{\gamma^2 - 1}{2\gamma}$.

Figure 4 shows the same data plotted in Fig. 3, analyzed graphically by the method outlined. To aid in determining the position of the straight line through the plotted points, the vertical scale in Fig. 4 is made one-tenth the horizontal scale. A comparison of the two methods shows that the new one is simpler and more direct than the older one. It has also the advantage that the method of least squares can readily be applied to the determination of the most probable values of C and γ in Eq. 7. A bulletin shortly to be issued by the University of Washington will outline this procedure in conjunction with a presentation of the results of shear strength tests on mortar specimens.

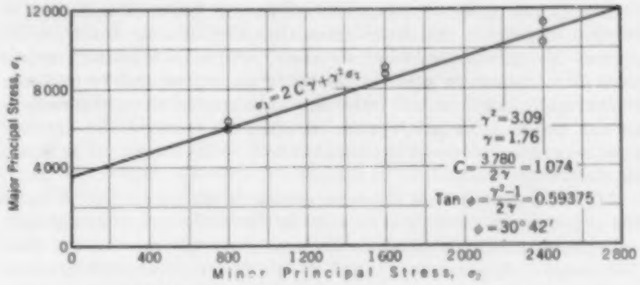


FIG. 4. NEW PLOTTING EVADES TANGENT CONSTRUCTION
Cohesion and Friction Found from Slope of Principal Stress Points

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Roger Sherman, Colonial Surveyor

TO THE EDITOR: A discussion by Hanson Z. Wilson, in the October issue, of my article on "Roger Sherman, Colonial Surveyor," in the Agusut issue, calls attention to a map of the Chesapeake Bay and environs compiled from notes take by Captain John Smith, circa 1606. Many such charts, compiled from notes and sketches taken down by navigators of the sixteenth and seventeenth centuries, may be found in museums, but it is the distinction of Norwood's map of Bermuda that it was compiled by an authorized land surveyor from notes taken by himself in the field. So far as records show, Norwood was the first to engage in the practice of land surveying in the English settlements of the New World.

Roger Sherman is honored for his contribution to representative government during the critical years of its establishment in this country. That he was an able successor to his forebears who practiced land surveying will be of interest to civil engineers.

Boston, Mass. EDWARD D. KINGMAN, Assoc. M. Am. C.E.

Topographic Map Revisions by Engineer Troops Seen as National Defense Measure

DEAR SIR: As part of our preparedness program, I believe it the duty of the Society to call the attention of the War Department to the archaic state of the topographic maps of this country. Should invasion come, it would be from these antiquated sheets that our defense lines would be laid out and firing data calculated.

These maps were surveyed 30 to 40 years ago when the country was in the "horse and buggy" age, and they make no distinction between country lanes and main highways. Since that time all the interurban and many of the branch railroads have been torn up. Main highways have been straightened and widened. Cities and suburbs, in some cases, have grown immensely. Old manufacturing plants have been abandoned, and new ones have been built.

Near my own city, there have been several large new bridges built and important hydroelectric projects completed, all of which are essential to national defense. One of the old pikes, originally a privately operated toll road, has been widened and straightened to become part of a transcontinental highway, an essential link in our transportation system.

There will be a number of engineer regiments in the army which is now being formed. It would be advisable as part of their training to correct and bring up to date these maps which might play an important part in the defense of the country. At the same time there should be, on the margin of the sheet, printed coordinates so that the map would be more readily available for military uses. Also on the map should be a list giving the capacities and clearances of bridges and underpasses on the main highways shown on that sheet, and these data should be corrected yearly.

Lancaster, Pa. ROBERT S. MAYO, M. Am. Soc. C. E.

Government Regulation

DEAR SIR: In Professor Howland's interesting and informative article, in the November issue, on "The Concept of Engineering—a Development of the Eighteenth Century," he states that Laissez faire is, in the theory at least, absence of control." This, I believe, is contrary to the general understanding of the term, which is defined in the Encyclopedia Britannica "as the doctrine which demands the minimum interference by government in economic and political affairs. . . .The most probable origin of the phrase is the well-known reply of the manufacturer Legendre to Colbert who asked what he could do for industry: 'Laissez-nous faire' (Let us alone)."

When it is considered that the French government under Colbert prescribed even the number of threads to the inch in the weaving of cloth, it is no wonder that the industrialists of that day wanted to be "let alone." This strict regulation by the French government in the seventeenth century was almost equal to that of the Japanese government in the same century, which prescribed for the common people the minutest detail of everyday life, such as the shaving of beards and the wearing of clothing. Would not an investigation of the results of this excessive regulation in these two countries be instructive? As a matter of fact, French industry suffered so much in foreign trade under this undue regulation, that it was unable to meet the competition of the industries of England and Holland, which were untrammeled by their home governments.

One of the original advocates of laissez faire, Mercier de la Rivière, expressed the same ideas that are now set forth by its present-day advocates, when he said: "Personal interest compels each man vigorously and continuously to perfect and to multiply the things he seeks to sell. He thus enlarges the mass of pleasures he can produce for other men, in order to increase the mass of pleasures other men can produce for him in exchange. The world thus advances itself."

All this indicates that the same economic questions that arose in the seventeenth century now arise in the twentieth century, notwithstanding the tremendous technological advance in the past 300 years. Apparently the only solution is that which solves many problems—moderation. We all know that the most essential things in life can be carried to excess. There is nothing more essential to life than eating, and yet even that can be overdone. The happy mean is difficult to attain, but the engineer who depends on the intellect for the solution of a given problem is more apt to succeed than is the politician who has an emotional outlook

Incidentally, I am sorry that Professor Howland identifies enlightened self-interest with greed. I like to think it was enlightened self-interest—not greed—which caused Carnegie, Rockefeller, and Ford, through improved technology and mass production, to lower, respectively, the prices of steel, oil, and automobiles—all to the profit of the general public, as well as to themselves. The profit motive, inherent in man, must be intelligently regulated for the benefit of the community but it must not be abolished. Communism, which is based on the theory that an individual will work as hard for the community as he will for himself, has always proved a failure, whether practiced on a small scale as at Brook Farm or on a large scale as in Soviet Russia.

PHILIP W. HENRY, M. Am. Soc. C.E.
Consulting Engineer
New York, N.Y.

General Formulas for the Catenary

TO THE EDITOR: On page 657 of CIVIL ENGINEERING for October 1940, Donald Bregman presented an interesting article on the "Parameter of Catenary Curve for Any Given Span and Dip." The writer noted a few typographical errors in Table I and has recomputed the table using the exponential functions listed in *Smithsonian Mathematical Tables* (1931).

TABLE I. CATENARY PARAMETERS

(1) k	(2) a_1	(3) $a_1k = b/D$	(1) k	(2) a_1	(3) $a_1k = b/D$
0.10	199.83	19.983	0.80	2.964	2.371
0.15	88.723	13.308	0.90	2.309	2.078
0.20	49.833	9.967	1.00	1.841	1.841
0.25	31.834	7.959	1.50	0.739	1.109
0.30	22.056	6.617	2.00	0.362	0.724
0.35	16.161	5.656	2.50	0.195	0.487
0.40	12.335	4.934	3.00	0.110	0.331
0.45	9.712	4.370	3.50	0.064	0.225
0.50	7.835	3.918	4.00	0.038	0.152
0.60	5.392	3.235	4.50	0.023	0.102
0.70	3.919	2.743	5.00	0.013	0.068

The usefulness of a table and graph of this type will be limited unless formulas are included covering a general case of the common catenary. Some of these equations have been overlooked in many texts and approximate solutions given when mathematically correct answers would have been feasible.

Using Mr. Bregman's example altered slightly to fit the revised Table I, $b/D = a_1k$ (Eq. 4), $D = 20$ ft, and $b = 266.17$ ft. Therefore $a_1k = 13.308$, $k = 0.15$, and $a_1 = 88.723$. From the author's Eq. 3, $a = Da_1 = 1{,}774.45$ ft. This is the ordinate at the Y-Y axis of Fig. 1 and also the radius of curvature at this point for the catenary. Many catenary relations are similar to right-triangle relations and from one of these we can develop the arc length (Eq. 5) $S = \sqrt{8aD + 4D^2} = 534.33$ ft. The span, $l = 2b = 532.34$ ft and the sag correction $(S\text{-}l) = 1.99$ ft.

The relation between "sloping" catenaries and a horizontal catenary of equal span and constant a is given by Eq. 10: $S_c = \sqrt{S^2 + h^2}$, where h is the difference in elevation of the two ends. (Let $h = 100$ ft, for example.) Then $S_c = \sqrt{534.33^2 + 100^2} = 543.61$ ft. The ordinate at midspan now will be $Y_3 = aS_c/S = 1{,}805.26$ ft (Eq. 11). The center-line sag $D_3 = \frac{S_c}{S} D = 20.35$ ft (Eq. 12). The arc length from the Y-Y axis to the ordinate Y_3 will be Eq. 13, $S_3 = \frac{Y_3h}{S_c} = 332.09$ ft, showing that the portion of the curve under discussion lies completely to one side of the Y-Y axis. The ordinates at the ends of S_c are given by Eq. 14, $Y = Y_3 + D_3 \pm h/2$. Then $Y_1 = 1{,}875.60$ and $Y_2 = 1{,}775.60$. The arc length to the lower end is $S_2 = \frac{Y_1^2 - Y_2^2 - S_c^2}{2S_c} = 64.02$ ft (Eq. 15), and $S_1 = S_2 + S_c = 607.63$ ft (Eq. 16). The abscissa at midspan (Eq. 17) is $X_3 = \frac{a}{2} \log_e \frac{S_c + h}{S_c - h} = 330.18$, and $X_1 = X_3 + b = 596.35$ ft, $X_2 = X_3 - b = 64.01$ ft.

The intrinsic equation for the catenary gives the midspan slope as $\tan \phi_0 = \frac{S_3}{a} = \frac{h}{S} = 0.18715$, (Eq. 18). As a back check on the work it might be well to substitute S_1, S_2, or S_3 in the general equation $Y^2 = S^2 + a^2$.

These are perhaps the most useful formulas and may be extended to cover uniform loads along the cable, for cable spinning, or for tension curves to be used by linemen.

ALLEN H. BROWNFIELD, Assoc. M. Am. Soc. C.E.
Sacramento, Calif.

Government Expenditures for Public Works

TO THE EDITOR: In an article on "Economic Studies for Public Works" by Messrs. Hyatt and Matthew, in the November number, it appears that, in amortization of the Central Valley Project of California in 40 years at 4½%, annual cost would exceed annual revenue; that, in 50 years at 3%, revenues would cover carrying charges; that, in financing under terms available to the State of California, cost would exceed revenue; that financing by the state could be justified only by inclusion of estimatedly large indirect benefits; and that the project is financed by the federal government on the basis of federal payment for cost of navigation and flood control improvement, and federal interest-free financing of the irrigation features of the project on long-time amortization, the U.S. Bureau of Reclamation doing the construction.

This project appears unjustifiable under the inexorable economic facts and requirements to which private enterprise and solvency must conform. It is one example of governmental duplication and extravagance, another example being concurrent federal expenditures by the Corps of Engineers, U.S. Army, of large prior appropriations for navigation and flood control within the limits of the subsequently approved project described above. These appropriations already impose upon navigation a ton-mile cost in excess of like cost of rail transportation within the same limits.

In assumptions and reasonings underlying paper justification of some of these governmental projects, one may be pardoned for entertaining the impression that wishful, political thinking is involved. Messrs. Hyatt and Matthew wisely say or imply that, as to projects requiring much support by indirection, caution should prevail, as it is the people's money that is being spent, the money is not unlimited, and the question of whether the people can afford it should have careful consideration. In view of the increase in the national debt and the imperative requirements of national defense, the question is pressingly timely—particularly in regard to additional commitments.

I should like, also, to say a word about the low interest rate or the entire absence of interest charges necessary for the government to justify some of its projects. The trend of the effect of a low rate may be toward cheapening the dollar and raising prices. Unless it correspondingly raises wages, the wage earner suffers. If, when the wage earner retires, he has accumulated and invested $25,000 at 6%, he will have $125 per month for old age security, but to get that much at 3%, he would have to accumulate $50,000. That, of course, applies to holders of government bonds. Low interest rate is no assurance of social security. It is assuredly a benefit only to the borrower, and borrowing is generally a misfortune for the majority of borrowers.

Oakland, Calif. J. L. CAMPBELL, M. Am. Soc. C.E.

Trend in Rainfall Records Confirmed

TO THE EDITOR: In the October issue George S. Knapp presented an interesting article, "Water Resources of the Mid-Continent Area," in which reference was made to data of similar character in U.S. Geological Survey Water Supply Paper No. 772. The records for the Mississippi River Basin above Keokuk, Iowa, which have been collected and furnished by the Mississippi River Power Company, have recently been brought up to date by this office, through which current-meter measurements are made to check the ratings in use at the dam.

The drainage area of the Mississippi River at Keokuk is approximately 119,000 sq miles. The operation of the navigation dams recently constructed on the main river has considerable effect on the daily discharges at Keokuk, especially during periods of rapidly changing river stage. Over a period of time, of course, these regulatory effects of flood-wave transmission are compensatory in so far as the total quantity of flow is concerned. There is, however, the possibility of increased evaporation and other losses under favorable circumstances over the enlarged areas of impounded waters. The significance of these interrelated factors is not definitely known, and their combined effect may or may not be measurable in terms of annual river discharge at Keokuk. Nevertheless, since long-time rainfall and temperature records are available, the basic data are useful and valuable in making a comparison of the climatologic and runoff trends.

The accompanying Fig. 1 shows the temperature, rainfall, runoff, and water-loss data for the period of discharge records at this station. The records of precipitation and temperature have been obtained from the official records of the U.S. Weather Bureau.

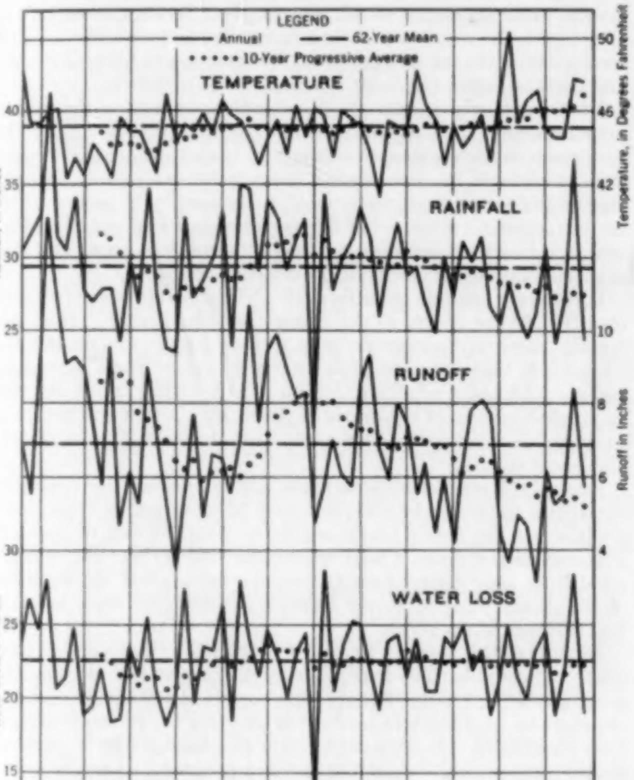


FIG. 1. CLIMATOLOGICAL AND RUNOFF DATA FOR MISSISSIPPI RIVER BASIN ABOVE KEOKUK, IOWA

As seen by the 10-year progressive averages, a rather marked decrease in rainfall has occurred since 1910. A fairly steady increase in mean annual temperature has occurred since the beginning of the record, this being particularly apparent in the last 10 years. Thus the gradual decrease in stream flow since 1910 is of material interest.

It is realized that such trends may be wholly due to natural phenomena or in part to the activities of man in making substantial changes on the earth's surface. Definite conclusions regarding these trends are beyond the scope of this discussion, and all such climatic trends may be somewhat cyclic in extent and character. However, it should be noted that the average water loss (rainfall minus runoff) during the years of study has shown less tendency to change progressively than either the rainfall or runoff. This suggests that the downward trend of runoff during recent years may be caused for the most part by the downward trend in the average supply as represented in the rainfall over the basin.

In any event, allowing for certain subjective limitations in the application of the moving-average type of analysis, definite and significant trends can be detected and records maintained without interruption for many years. As Mr. Knapp has indicated, a general decrease in stream flow deserves careful consideration in relation to increased use and wide conservation of the water losses in this agricultural area.

L. C. CRAWFORD, Assoc. M. Am. Soc. C.E.
District Engineer, Hydraulics Laboratory,
Iowa City, Iowa *U.S. Geological Survey*

Weather Cycles—Again?

TO THE EDITOR: Georse S. Knapp, in his article on "Water Resources of the Mid-Continent Area," in the October issue, states "...we are confronted with no short weather cycle" and says in effect that it will take us in the Western Great Plains some time to get down off the hump in mean annual temperature that has been building up for the past 50 years even though a reversal of trend should set in soon. The inference is that long-range planning should be adjusted accordingly. True, the present ground-water depletion will take time to restore but the running average method Mr. Knapp uses offers no evidence that we are confronted with a long-range weather cycle. It reveals the trends in the past but offers no clue as to the future.

I took the 67-year record of mean annual temperatures at Denver, Colo., with a mean of 50.4 F, plotted on the accompanying Fig. 1 (*a*), and found the standard deviation, sigma, or the mean-root-square to be 1.4 F. All but one observation fall within the limits of ±3 sigma.

Thinking that if this were a random distribution and yet still contained the trends upon which Mr. Knapp bases his conclusions I would scramble the data and see what happened, I put the original observations on small cards and thoroughly mixed the 67 individual items. Then I pulled them out of the pile at random, added them again in 10-year moving averages, Fig. 1 (*b*), and plotted them in Fig. 1 (*c*). It can be observed that in Fig. 1 (*c*) the "cycles" are, if anything, more apparent than in Fig. 1 (*b*).

One requisite of chance is that no one of the numerous forces involved shall be dominant during the interval of time involved.

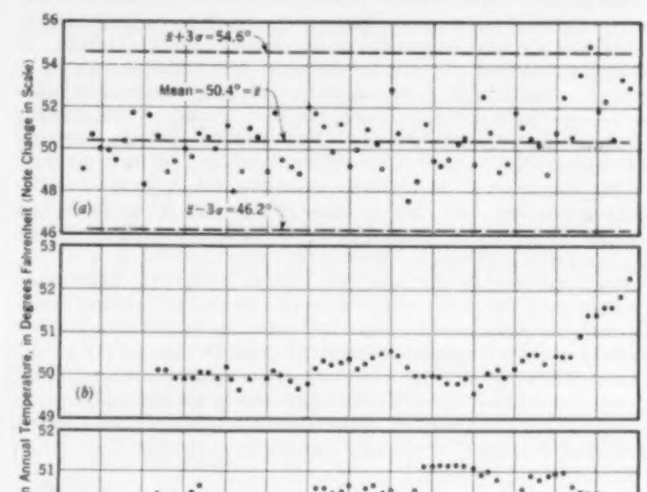


FIG. 1. TEMPERATURES AT DENVER, COLO.

(*a*) As Recorded; (*b*) Plotted in 10-Year Running Averages; and (*c*) Data Scrambled and Replotted in 10-Year Running Averages

In 1932 I made a study similar to Mr. Knapp's, using the 5-year running average. A cycle in annual sun-spot data was apparent and persistent, but the terrestrial temperatures followed erratically, if at all. Other and unknown influences seemed to lengthen or shorten, to increase or dampen, or to entirely obliterate the corresponding waves shown in the sun-spot data.

The general 50-year rising trend that Mr. Knapp mentions was apparent at certain stations, but it was not universal. The graph for Cheyenne, Wyo., for instance, showed no rise at all up to that year but a gentle slope downward, if anything. The graph for the Denver data plotted in 10-year running averages does not begin to rise definitely above all previous high points until 1932. Forecasting from that year, one would have turned the trend downward in conformity with previous "cycles."

This brief excursion into statistical analysis is not intended to show, of course, that we have not had a dry period; obviously we have. It merely indicates that the 10-year running average method of treating mean annual temperatures is not an adequate procedure for predicting future weather trends.

We may be facing a sudden return of cold and wet years instead of a long dry "cycle." Glaciologists and geologists who have been watching the recession of glaciers through these dry warm years state that it may be only a temporary recession of the present "little ice age." In the 1940 *Transactions of the Geophysical Union*, the Committee on Glaciers states: "It is significant in any event that in spite of their recent recession the Swiss and French glaciers today are still much longer than they were during the Middle Ages. The sites of the villages that were overwhelmed by them in the catastrophic advance in 1643–1644 are still under the ice."

Denver, Colo. ROBERT EAKER KENNEDY, M. Am. Soc. C.E.

Need for Economic Justification of Public Works

DEAR SIR: In regard to the article on "Economic Studies for Public Works," by Messrs. Hyatt and Matthew, in the November issue, it is heartening to note that public works engineers are beginning to think in terms of economic justification. However, it is unfortunate that they waited to do this until the country was saddled with a huge public debt, much of which was incurred by reckless and improvident spending of public funds with their help.

The writer regrets that he finds nothing in the article that justifies the Central Valley Project on economic grounds. The sole offer of economic justification is the increased business to be done by certain metropolitan centers. How that is to benefit the state of California or the nation is not shown. It is conceivable that it would justify the expenditure in the minds of the business interests and residents of the metropolitan centers which are to be benefited, but it does not seem to justify the use of state or federal funds. It is not claimed that any new industries or new businesses are to be created. One gets the impression that it is proposed to take existing business from other sections of the state or country and transfer it to these metropolitan centers. If such is the case, the financing of this enterprise is a matter for the metropolitan centers to arrange.

This discussion is based solely upon the data presented in the published article. By that measure this project seems to be just another burden to be fastened upon the back of industry. In the last analysis it is American industry that pays the bill.

Some years ago the National Association of Manufacturers made a survey from which the cost of six staple articles of food and clothing and two luxury items was determined in terms of hours and minutes of labor required to earn the price of each article in the United States and in seven of the largest European countries. This survey showed that the cost of these articles in the United States in terms of labor (the yardstick of the economist) ranged from about 4 to 60% of the cost of corresponding articles in the European countries.

A comparison was also made of the quality of some of these articles. For example, it was found that a pair of overalls that cost about ten times as much in the country where they were purchased as did the American counterpart, lost 18.4% in weight and 3.8% in area with one washing. The inspection laboratory estimated that these overalls would wear about one-third as long as the American-made overalls.

America has more of the comforts and luxuries of life than any other nation in the world per capita of population. Why? Because American labor can live cheaper and better than the labor of any other country in the world. Therefore it has more surplus to spend for luxuries and extra comforts, thus creating new business and new industries which employ more labor.

If the bureaucratic system which has grown up like a thistle in our fertile soil is allowed to continue to choke out our technical progress and our industry and siphon off the free-venture capital that is the life blood of industry into non-productive fixed capital "investments," there will be no surplus with which to create new business and new industries. Technical progress and invention will cease, and some Gibbon of the future will be writing about the rise and fall of the American Republic.

The engineering profession should be the first to grasp the significance of this trend and to make every effort to stem the tide that is rapidly engulfing us, to the end that our system of free enterprise may be preserved and our progress and prosperity continue. The profession has so far failed to accept its responsibility. Instead of resisting the trend toward bureaucracy, it has done as much as any other agency to promote it and to jealously guard its entrenched position. Instead of working to preserve free enterprise it has been working with unthinking stupidity to help build up this octopus which is rapidly devouring us.

WALTER H. WHEELER, M. Am. Soc. C.E.
Minneapolis, Minn. *Designing and Consulting Engineer*

Engineering in the Eighteenth Century

DEAR SIR: It is a pleasure to find in CIVIL ENGINEERING an occasional article that gives something of the historical background of our profession. A valuable example of this kind is W. E. Howland's "The Concept of Engineering—a Development of the Eighteenth Century," which brings out the fact that the need for formal education for civil engineers was first appreciated in France, and that the profession, itself, was first recognized there.

I believe, however, that Mr. Howland's treatment of the subject may lead to certain misconceptions. While granting that social conditions in the eighteenth century, in both England and France, were intolerable, he stresses the unfavorable features in England and amplifies the "enlightenment" in France. He points to the famous scientists produced at this time by state-fostered education, and finds that England's few engineers of note "just grew" and were generally unlettered mechanics of unusual genius.

It is hardly possible to make a fair comparison between two such utterly different people as the English and the French. If one attempts, however, to contrast their technical achievements it is not improbable that the "just grew" party will share the honors quite equally with their neighbors. As a matter of fact, there was also an English system of education in those days, and it will not do to pass over as exceptions such men as Newton, Wren, Hooke, Halley, and many others.

Recently I read of a remarkable and somewhat daring survey expedition made by the great scientist, Maupertuis, in 1736. At a point where the Arctic Circle crosses a certain stream in Lapland, Maupertuis laid down a base line on the frozen river and triangulated from snow-covered peaks, in order to measure an arc of the meridian and thus to verify Newton's contention that the earth was flattened at the poles.

His 9-ft radius sextant, invented by Newton, was made in England. The graduations were made by the hand of Mr. Graham, the great physicist. When Maupertuis corrected his observations on the stars he used the new method of allowing for the aberration of light devised by Mr. Bradley. Here is a fair picture of internationalism in science. It would be daring, indeed, to try to isolate the achievements of the different nations.

Mr. Howland has recognized Voltaire as the symbol of the times in France. Yet the fugitive Voltaire, early in life, found a haven in England where he could escape the persecutions of an intolerant French aristocracy, and where he was not unaffected by English ideas of intellectual freedom.

It may be questioned whether Mr. Howland's picture of eighteenth century England is not really nineteenth as suggested by the editor's illustration, "Interior of an English Type Foundry, Middle of the Nineteenth Century." If comparisons must be made, it would seem only fair to contrast French and English science in the eighteenth century. Not French science in the eighteenth century and English economics in the nineteenth.

Washington, D.C. JEROME FEE, Assoc. M. Am. Soc. C.E.

Eighty-Eighth Annual Meeting

New York, N.Y., January 15–17, 1941
Program of Sessions, Entertainment, and Trips

Business Meeting, Prize Awards, Conferring of Honorary Membership, and Presentation of John Fritz Medal

WEDNESDAY—January 15, 1941—Morning

Auditorium

9:00 **Registration**

10:00 **Eighty-Eighth Annual Meeting called to order by**

John P. Hogan, *President, American Society of Civil Engineers, Consulting Engineer,* New York, N.Y.

Report of the Board of Direction

Report of the Secretary

Report of the Treasurer

10:30 **Presentation of Society Medals and Prizes**

The Normal Medal to Shortridge Hardesty, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y., and Harold E. Wessman, *M. Am. Soc. C.E., Chairman, Department of Civil Engineering, and Professor, Structural Engineering, College of Engineering, New York University,* New York, N.Y., for Paper No. 2029, "Preliminary Design of Suspension Bridges."

The J. James R. Croes Medal to Edward J. Rutter, *Assoc. M. Am. Soc. C.E., Hydraulic Engineer, TVA,* Knoxville, Tenn., Quintin B. Graves, *Assoc. M. Am. Soc. C.E., Instructor in Civil Engineering, Department of Civil Engineering, University of Texas,* Austin, Tex., and Franklin F. Snyder, *Jun. Am. Soc. C.E., With Central Office, U.S. Weather Bureau,* Washington, D.C., for Paper No. 2022, "Flood Routing."

The Thomas Fitch Rowland Prize to J. D. Galloway, *Hon. M. Am. Soc. C.E., Consulting Engineer,* San Francisco, Calif., for Paper No. 2015, "The Design of Rock-Fill Dams."

The James Laurie Prize to A. M. Rawn, *M. Am. Soc. C.E., Chief Engineer and General Manager, Los Angeles County Sanitation Districts,* Los Angeles, Calif., A. Perry Banta, *Assoc. M. Am. Soc. C.E., Assistant Professor, Sanitary Engineering, California Institute of Technology, and Assistant Engineer, Los Angeles County Sanitation Districts,* Los Angeles, Calif., and Richard Pomeroy, *Ph.D., Research Chemist and Bacteriologist,* Altadena, Calif., for Paper No. 2016, "Multiple-Stage Sewage Sludge Digestion."

The Collingwood Prize for Juniors to Kenneth D. Nichols, *Jun. Am. Soc. C.E., Captain, Corps of Engineers, U.S.A., Instructor, Department of Civil and Military Engineering, U.S. Military Academy,* West Point, N.Y., for Paper No. 2044, "Observed Effects of Geometric Distortion in Hydraulic Models."

The Rudolph Hering Medal to J. W. Ellms, *M. Am. Soc. C.E., Commissioner of Sewage Disposal, Department of Public Utilities,* Cleveland, Ohio, Chairman of the Sanitary Engineering Division Committee which developed the Manual on "The Design and Functions of Water Treatment Plants."

The Construction Engineering Prize to Russell G. Cone, *M. Am. Soc. C.E., Engineer, Golden Gate Bridge and Highway District,* San Francisco, Calif., for Civil Engineering Paper No. 1124, "Field Practice with Special Reference to Golden Gate Bridge."

Toe Daniel W. Mead Prize to Allen Jones, Jr., *Jun. Am. Soc. C.E., 17th Engineer Battalion (Armored),* Fort Benning, Ga., for the best paper by a Junior of the Society on the subject of Professional Ethics.

11:00 **Conferring of Honorary Membership**

Charles P. Berkey, *M. Am. Soc. C.E., Newberry Professor Emeritus of Geology, Columbia University,* New York, N.Y.

Prof. Berkey will be presented to the President by Ole Singstad, *M. Am. Soc. C.E., Chief Engineer, New York City Tunnel Authority,* New York, N.Y.

George H. Fenkell, *M. Am. Soc. C.E., Consulting Engineer,* Almont, Mich.

Mr. Fenkell will be presented to the President by Henry E. Riggs, *Past-President, Am. Soc. C.E., Honorary Professor, Civil Engineering, University of Michigan,* Ann Arbor, Mich.

J. D. Galloway, *M. Am. Soc. C.E., Consulting Engineer,* San Francisco, Calif.

Mr. Galloway will be presented to the President by Charles Gilman Hyde, *M. Am. Soc. C.E., Professor of Sanitary Engineering, University of California,* Berkeley, Calif.

F. G. Jonah, *M. Am. Soc. C.E., Chief Engineer, St. Louis–San Francisco Railway,* St. Louis, Mo.

Mr. Jonah will be presented to the President by E. B. Black, *M. Am. Soc. C.E., Consulting Engineer,* Kansas City, Mo.

Reginald H. Thomson, *M. Am. Soc. C.E., Consulting Engineer,* Seattle, Wash.

Mr. Thomson will be presented to the President by Joseph Jacobs, *Vice-President, Am. Soc. C.E., Consulting Engineer,* Seattle, Wash.

11:30 **Presentation of John Fritz Medal to**

Ralph Budd, *M. Am. Soc. C.E., President, Chicago, Burlington and Quincy Railroad,* Chicago, Ill.

Introduction of Henry E. Riggs, *Past-President, Am. Soc. C.E., Chairman, John Fritz Medal Board of Award.*

Statement by Chairman Riggs on history and purpose of the Medal.

Address on achievements of the medalist by A. W. Newton, *M. Am. Soc. C.E., Consulting Engineer, Chicago Burlington and Quincy Railroad,* Chicago, Ill.

Presentation of the John Fritz Medal to Ralph Budd by William Henry Harrison, *Past-President, American Institute of Electrical Engineers, and Chairman of the John Fritz Medal Board* that made the award.

12:00 **New Business**

Report of Tellers on Canvass of Ballot for Officers

Introduction of President-Elect and New Officers

12:30 **Luncheon**

Fifth Floor, Engineering Societies Building. Tickets $1.00 each.

General Meeting

Under Auspices of the Committee on Civilian Protection in Case of War

WEDNESDAY—January 15, 1941—Afternoon

Auditorium—Time, 2:30 p.m.

GEORGE L. LUCAS, *Vice-President, Am. Soc. C.E., Chairman*
WALTER D. BINGER, *Chairman, Committee on Civilian Protection, Presiding*

The Board of Direction of the American Society of Civil Engineers at its meeting on October 15, 1940, authorized the appointment of a Special Committee to study the needs of civilians in the event of hostilities, looking to those measures for providing the most ample possible protection of life and property against attack.

Not alone is the problem one of the protection against loss of life by the use of air shelters but also of protecting water supplies and other utilities against damage and sabotage as well as from air bombing.

The program is planned as a round-table discussion with participation from the floor with reasonable restriction on time allotted to speakers for the purpose of developing suggestions and exchange of experiences.

The Committee, headed by WALTER D. BINGER, *M. Am. Soc. C.E., Commissioner of Borough Works, Borough of Manhattan*, New York, N.Y., as Chairman, and ERNEST P. GOODRICH, *Director, Am. Soc. C.E., Consulting Engineer*, New York, N.Y., as Vice-Chairman, has been selected with a view of covering the five main subdivisions of the subject, as follows:

2:30 **Structural—Bridges, Buildings**

J. I. PARCEL, *M. Am. Soc. C.E., Consulting Engineer*, St. Louis, Mo.

Sanitation and Public Health

SAMUEL A. GREELEY, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill.

Transportation and Distribution

CHARLES B. BREED, *M. Am. Soc. C.E., Professor of Railway and Highway Transportation, and Head of Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology*, Cambridge, Mass.

Power and Communications

PHILIP SPORN, *M. Am. Soc. C.E., Vice-President and Chief Engineer, American Gas and Electric Service Corporation*, New York, N.Y.

Emergency Control, Sabotage, Camouflage

ALLEN J. SAVILLE, *M. Am. Soc. C.E., Consulting Engineer*, Richmond, Va.

Student Conference

WEDNESDAY—January 15, 1941—Afternoon

Room 1, Fifth Floor

A. H. HOLT, *M. Am. Soc. C.E., Head, Civil Engineering Department, Worcester Polytechnic Institute*, Worcester, Mass., *Chairman*
SIDNEY WENIGER, *Chairman, Conference of Metropolitan Student Chapters, Presiding*

2:30 **Presentation of Daniel W. Mead Prize to Harry A. Balmer, George Washington University Chapter, Washington, D.C., for best paper on Professional Ethics by a member of a Student Chapter.**

Address on the **Progress of Certain Civil Engineering Methods and Ideas from Earliest History,** delivered by STARR TRUSCOTT, *M. Am. Soc. C.E., Aeronautical Engineer, National Advisory Committee for Aeronautics*, Langley Field, Va.

Address on **The Young Engineer and National Defense,** by COL. JOHN P. HOGAN, *outgoing President of the Society, and Chairman, Construction Advisory Committee, Army and Navy Munitions Board.*

Smoker

WEDNESDAY—January 15, 1941—Evening

Committee: R. R. GRAHAM, *Chairman*, F. R. W. CLEVERDON, MORRIS ATKIN, ARCHIE N. CARTER, LAURENCE F. GRANGER, and GEORGE G. HAYDEN

Place—Manhattan Center, 311 West 34th Street (34th Street near Eighth Avenue)

Time—8:00 p.m. Doors open at 7:30 p.m.

For this year's Smoker, Manhattan Center, with its newly arranged and decorated Ball Room on the street floor, has been selected by the Committee as a place which is not only convenient but also spacious enough to accommodate with ease the large number of members and guests to be expected.

Beginning at 8:00 o'clock there will be a number of entertainment features, lasting about an hour. Following this the evening, as late as members may wish to stay, will be free for meeting old friends and renewing acquaintanceships. Of course, there will be the customary smokes and refreshments.

Members' Tickets—$1.00 each.
Guest Tickets—$2.00 each.

IMPORTANT!! Please note dates of SMOKER and DINNER DANCE—
SMOKER on Wednesday and DINNER DANCE on Thursday

Sessions of Technical Divisions Occupy Entire Day

THURSDAY—January 16, 1941—Morning

POWER DIVISION

William P. Creager, *Chairman of Executive Committee of the Power Division, Chairman*

Maurice R. Scharff, *Chairman, Joint Committee on Depreciation, Presiding*

FUNDAMENTAL ASPECTS OF THE DEPRECIATION PROBLEM

Program prepared by the Joint Committee on Depreciation, composed of representatives of the Power, City Planning, Construction, Engineering Economics, Highway, Sanitary Engineering, and Surveying and Mapping Divisions

10:00 **Theory and General Principles of Depreciation**
Dr. Gabriel A. D. Preinreich, *Certified Public Accountant*, New York, N.Y.

10:30 **Depreciation in Relation to Regulated Industry**
J. A. Walls, *M. Am. Soc. C.E., President, Pennsylvania Water and Power Company and Safe Harbor Water Power Corporation*, Baltimore, Md.

10:45 **Depreciation in Relation to Competitive Industry**
Eugene L. Grant, *M. Am. Soc. C.E., Associate Professor of Economics of Engineering, Stanford University, Department of Civil Engineering*, Stanford University, Calif.

11:00 **Depreciation in Relation to Public Works and Governmental Finance**
R. W. Crum, *M. Am. Soc. C.E., Director, Highway Research Board, National Research Council*, Washington, D.C.; and Robley Winfrey, *Assoc. M. Am. Soc. C.E., Research Associate Professor, Highways and Valuation, Iowa State College*, Ames, Iowa.

11:15 **Discussion**

11:15 **Discussion opened by**
H. J. Flagg, *M. Am. Soc. C.E., Chief Engineer, New Jersey Board of Public Utility Commissions*, Newark, N.J.

N. B. Jacobs, *M. Am. Soc. C.E., President, Morris Knowles, Inc.*, Pittsburgh, Pa.

C. Beverley Benson, *A. Am. Soc. C.E., Principal Statistician (Engineering), New York Public Service Commission*, New York, N.Y.

Nelson Lee Smith, *Chairman, New Hampshire Public Service Commission*, Concord, N.H.

Paul T. Norton, Jr., *Professor, Virginia Polytechnic Institute*, Blacksburg, Va.

SANITARY ENGINEERING DIVISION

Earle L. Waterman, *Chairman, Executive Committee, Presiding*

10:00 **Presentation of Reports of Division Committees**

(1) **Committee on Sewer Rental Laws and Procedure (Progress Report)** Earl Devendorf, *Assoc. M. Am. Soc. C.E., Assistant Director, New York State Health Department*, Albany, N.Y., *Chairman*.

(2) **Committee on Sewerage and Sewage Treatment (Progress Report)** Langdon Pearse, *M. Am. Soc. C.E., Sanitary Engineer, The Sanitary District of Chicago, Chairman*.

(3) **Committee on Advancement of Sanitary Engineering** Charles Gilman Hyde, *M. Am. Soc. C.E., Professor of Sanitary Engineering, University of California*, Berkeley, Calif., *Chairman*.

(4) **Committee on Rudolph Hering Medal Award,** Linn H. Enslow, *Assoc. M. Am. Soc. C.E., Sanitary Engineer, The Chlorine Institute, Inc.*, New York, N.Y., *Chairman*.

General Discussion

STRUCTURAL DIVISION

10:00 **Report of the Joint Committee on Concrete and Reinforced Concrete**

Charles F. Goodrich, *M. Am. Soc. C.E., Chairman Executive Committee, Chairman*

F. E. Richart, *M. Am. Soc. C.E., Research Professor, Engineering Materials, University of Illinois*, Urbana, Ill., *Vice-Chairman of Joint Committee, Presiding*

The following sections of the Joint Committee Report will be explained by members of the Committee, followed by general discussion:

Materials, Proportioning, Mixing and Curing, Details of Design and Construction, Design, General Discussion

CITY PLANNING DIVISION

Harland Bartholomew, *Chairman, Executive Committee, Presiding*

10:00 **City Planning Implications of the 1940 Census**
Dr. Julius B. Maller, *Chief, Social Research Section, U.S. Housing Administration*, Washington, D.C.

10:30 **Progress Toward the Master Plan of New York City**
T. T. McCrosky, *M. Am. Soc. C.E., Director of Planning, Department of City Planning*, New York, N.Y.

11:00 **General Discussion**

Courtesy American Airlines

LaGuardia Field—Main Point of Interest on Friday's Excursion

Sessions of Technical Divisions

THURSDAY—January 16, 1941—Afternoon

HIGHWAY DIVISION

WILLIAM NELSON CAREY, *Chairman, Executive Committee, Presiding*

2:30 **Design and Construction of the Runways for the Washington National Airport**

E. L. TARWATER, *Highway Engineer, Public Roads Administration,* Washington, D.C.

3:00 **Airport Runway Design**

GEO. H. BUNKER, *Vice-President and General Manager, The Interstate Amiesite Company,* Wilmington, Del.

3:30 **Army Airport Construction Under the Negotiated Contract System**

M. W. COCHRAN, *Major, Q.M.C., Office of the Quartermaster General,* Washington, D.C.

4:00 **General Discussion**

WATERWAYS DIVISION

RALPH H. MANN, *Member, Executive Committee, Presiding*

2:30 **Allocation of Costs in Multiple Purpose Projects**

R. E. COUGHLIN, *M. Am. Soc. C.E., Major, Corps of Engineers, U.S.A., with Board of Engineers for Rivers and Harbors,* Washington, D.C.

3:00 **Discussion opened by**

C. H. PAUL, *M. Am. Soc. C.E., Consulting Engineer,* Dayton, Ohio.

3:20 **Allocation of Costs in the TVA**

T. B. PARKER, *M. Am. Soc. C.E., Chief Engineer, TVA,* Knoxville, Tenn.

3:50 **Discussion opened by**

WILLIAM P. CREAGER, *M. Am. Soc. C.E., Consulting Engineer,* Buffalo, N.Y.

STRUCTURAL DIVISION

Program Sponsored by Structural Division Committee on Applied Mechanics

E. L. ERIKSEN, *Chairman, Structural Division Committee on Applied Mechanics, Presiding*

2:30 **The Present Status of Three-Dimensional Photoelasticity**

RAYMOND D. MINDLIN, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, Columbia University,* New York, N.Y.

3:00 **Discussion**

3:15 **The Prediction of Earthquake Stresses**

M. A. BIOT, *Assistant Professor of Mechanics, Columbia University,* New York, N.Y.

3:45 **Discussion**

4:00 **Bending Moments in the Walls of Rectangular Tanks**

DANA YOUNG, *Assoc. M. Am. Soc. C.E., Professor and Head, Department of Civil Engineering, University of Connecticut,* Storrs, Conn.

4:30 **Discussion**

4:45 **Structural Behavior of I-Shaped Sections as Indicated by Small Scale Models**

L. C. MAUGH, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, University of Michigan,* Ann Arbor, Mich.

5:15 **Discussion**

SANITARY ENGINEERING DIVISION

EARLE L. WATERMAN, *Chairman, Executive Committee, Presiding*

2:30 **Sewage Clarification and Grease Removal**

ALMON L. FALES, *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass., and SAMUEL A. GREELEY, *M. Am. Soc. C.E., Consulting Engineer,* Chicago, Ill.

3:00 **Discussion opened by**

A. M. RAWN, *M. Am. Soc. C.E., Chief Engineer and General Manager, Los Angeles County Sanitation Districts,* Los Angeles, Calif.

ARTHUR D. WESTON, *M. Am. Soc. C.E., Chief Engineer, Massachusetts Department of Public Health,* Boston, Mass.

General Discussion

BRONX-WHITESTONE BRIDGE TO BE SEEN ON FRIDAY'S EXCURSION

EXAMPLE OF PARKWAY DEVELOPMENT ON LONG ISLAND APPROACH TO BRONX-WHITESTONE BRIDGE

Entertainment for the Ladies

THURSDAY—January 16, 1941—Afternoon

Hotel Biltmore

LUNCHEON FOR LADIES FOLLOWED BY FASHION SHOW

GRAND BALLROOM, HOTEL BILTMORE
43RD STREET AND MADISON AVENUE

Committee: R. R. Nace, *Chairman*, Homer R. Seely, *and* F. C. Rogers

12:30 **Ladies Luncheon and Fashion Show**

For the entertainment of ladies, the Committee has arranged for a luncheon, to be followed by a fashion show in the Grand Ballroom of the Hotel Biltmore.

The fashion show, which will start about 2:30 p.m. following luncheon, will be presented by Franklin Simons, the famous Fifth Avenue specialty store. Miss Audrey McLaughlin, Fashion Show Director for the store, will do the announcing.

Fashions shown in this collection will be the highlights from the mid-winter openings and will include daytime and evening clothes, millinery, jewelry and other accessories. Costumes will be grouped for town, country and resort wear and will be of unusual interest to women who plan to spend the winter at home or traveling.

Tickets for the luncheon and afternoon entertainment are 75 cents each.

Dinner, Reception, and Dance

THURSDAY—January 16, 1941—Evening

Hotel Waldorf-Astoria

Committee: E. Warren Bowden, *Chairman*, Joseph W. Barker, Ellis E. Paul, C. L. Dalzell, Sherman Glass, *and* A. V. Rizzi

7:00 Assembly

7:45 Dinner

9:30 Reception to the President, the Honorary Members, and the John Fritz Medalist

10:00 Dancing

This function will be held in the Grand Ballroom of the Hotel Waldorf-Astoria, Park Avenue and 50th Street.

Dinner will be served promptly at 7:45 p.m.

Arrangements have been made for tables seating ten persons, and members may underwrite complete tables. Orders to underwrite a table must be accompanied by check in full and a list of guests.

Tickets will be \$6.00 each. Tickets for Juniors, for the dance only, will be \$2.00 per couple.

The seating list for the dinner dance will close at 5:00 p.m., Wednesday, January 15, 1941. Those who purchase tickets after that hour will be assigned to tables in the order of purchase. Tickets will be on sale at Society Headquarters until 5:00 p.m., Thursday, January 16, 1941.

Motion Picture of Tacoma Bridge Failure and Excursion to LaGuardia Airport Are Features for Friday

FRIDAY—January 17, 1941—All Day

MOTION PICTURE OF THE TACOMA NARROWS BRIDGE FAILURE

9:30 A. M.—AUDITORIUM

Because of the widespread interest in the accident to the Tacoma Bridge and in the excellent picture taken of the bridge prior to failure, a motion picture film has been prepared for this occasion.

Following the showing of the film, members, ladies, and guests will leave the Engineering Societies Building in buses and will proceed to the New York Municipal Airport, LaGuardia Field, at North Beach.

EXCURSION TO LAGUARDIA FIELD, NEW YORK MUNICIPAL AIRPORT

BUSES LEAVE ENGINEERING SOCIETIES BUILDING AT 11:00 A.M.

Committee: E. L. Macdonald, *Chairman, and* Sidney M. Shapiro

Buses leave Engineering Societies Building at 11:00 a.m. for LaGuardia Field, New York Municipal Airport, at North Beach.

On leaving Society Headquarters, the excursion will pass through the newly opened Queens-Midtown Tunnel. On arrival at the Queens exit of the tunnel a stop will be made for an inspection of the control, ventilation and other operating facilities of the tunnel.

After this inspection, the excursion will then proceed directly to the airport, where luncheon will be served in the beautiful Aviation Terrace Restaurant, which affords a view of the air field and arriving and departing planes.

After luncheon, members, ladies, and guests will be conducted on a tour "behind the scenes" of some of the great air transport companies. This trip will afford an inspection of one of the finest and largest operations and maintenance bases in the country, its land and marine terminal buildings, and other ultra-modern airport facilities, including hangars, radio control rooms, weather bureau, school for pilots and stewardesses, and flight maintenance and overhaul shops.

A trans-Atlantic Clipper Ship and a coast-to-coast Stratoliner will be exhibited if possible.

Following the inspection of the airport, the party will board the buses for the return, which has been arranged to afford a view of some of the major improvements of the Metropolitan area, including the recently opened Bronx-Whitestone Bridge, the Triborough Bridge, Wards Island Sewage Treatment Plant, and the new East Side Drive.

The excursion will terminate at Engineering Societies Building about 5:00 p.m.

Tickets for the trip, including luncheon, are \$2.50 each.

College Reunions Throughout the Week

WEDNESDAY—January 15, 1941

University of Illinois Engineers' Supper Reunion

For the thirteenth consecutive year civil engineer graduates of the University of Illinois and their friends will meet for an informal supper reunion at 5:45 p.m., on Wednesday evening, January 15, 1941. The rendezvous has been chosen at a cozy restaurant within five minutes' walk from Manhattan Center—Bonat Restaurant, 330 West 31st Street, New York, N.Y., one block from Penn Station and directly across the street from the main post office. Price $1.00—alumni and teachers and friends—no speeches or formality—and dismissal in ample time to attend the Smoker. Notify S. A. Olin, at Parsons, Klapp, Brinckerhoff and Douglas, 142 Maiden Lane, New York, N.Y. (Whitehall 3-0820).

University of Pennsylvania Civil Engineers' Dinner

The twenty-second annual informal dinner of the University of Pennsylvania Civil Engineers will be held at the University of Pennsylvania Club, Phi Gamma Delta Fraternity House, 106 West 56th Street, New York, N.Y., on Wednesday, January 15, 1941, from 6:00 to 7:30 p.m. Dinner will be served at 6:00 p.m. sharp. The charge per cover will be $1.50. Any further information can be obtained from Albert B. Hager care, Atlantic, Gulf and Pacific Company, 15 Park Row, New York, N.Y.

Rugers University Annual Dinner

Rutgers University civil engineering alumni will meet for their annual dinner at 6:00 p.m., on Wednesday, January 15, 1941, at the Hotel Bristol, 129 West 48th Street, New York, N.Y. The charge will be $1.00 per cover. Send checks to C. H. Gronquist, Room 1104, 117 Liberty Street, New York N.Y.

THURSDAY—January 16, 1941

Luncheon of Brown Engineering Association

The Brown Engineering Association will hold an informal luncheon meeting at the Hotel Bristol, 129 West 48th Street, New York, N.Y., on Thursday, January 16, 1941, at 12:30 p.m. All Brown alumni are invited. Please notify Sydney Wilmot, 33 West 39th Street, New York, N.Y. (Pennsylvania 6-9220).

Luncheon of Chi Epsilon Honorary Civil Engineering Fraternity

Members of Chi Epsilon, their families and their friends, are again extended a cordial invitation to attend a very informal luncheon at the Midston House, 22 East 38th Street, New York, N.Y., on Thursday, January 16, 1941, at 1:15 p.m. The charge will be $1.00 per person. Notify R. I. Land, 100 East 42nd Street, New York, N.Y. (Ashland 4-3300, Ext. 194).

Luncheon of M.I.T. Engineers

All M.I.T. alumni are invited to a luncheon at the Technology Club of New York, 24 East 39th Street, New York, N.Y., on Thursday, January 16, 1941, at 12:30 p.m. Please notify the Technology Club (Caledonia 5-8424) as to attendance.

Luncheon of Penn State Engineers

All Penn State civil and sanitary engineers with their families and friends are invited to lunch together in the Crest Room, King Edward Hotel, 120 West 44th Street, New York, N.Y., on Thursday, January 16, 1941, at 12:30 p.m. This is our first luncheon and your support is needed. Luncheon price will be 85 cents. No formalities or speeches. Please notify Arthur P. Miller, Sub-Treasury Building, Wall Street, New York, N.Y. (Bowling Green 9-0046) if you are going to attend.

FRIDAY—January 17, 1941

New York University Civil Engineers Annual Reunion Dinner

The annual reunion dinner of the New York University Civil Engineers will be held on Friday, January 17, 1941, at 6:30 p.m., at Janssen's Hofbrau, Lexington Avenue at 44th Street, New York, N.Y. The charge will be $1.75 per plate. Send reservations to Seymour Male, 35 Summit Avenue, Portchester, N.Y.

Thayer Society of Engineers of Dartmouth College

The annual meeting and dinner of the Thayer Society of Engineers of Dartmouth College will be held at the Dartmouth Club, 30 East 37th Street, New York, N.Y., on Friday, January 17, 1941, at 6:30 p.m.

Dinner of Cornell Society of Engineers

A dinner of the Cornell Society of Engineers will be held on Friday, January 17, 1941, at 6:30 p.m. at the Cornell Club, 107 East 48th Street, New York, N.Y.

Dinner of Columbia Engineers

The graduates of Columbia University who are members of the Society will meet for their twentieth informal dinner on Friday, January 17, 1941, at 6:30 p.m., at the Columbia University Club, 4 West 43d Street, New York, N.Y. Our guest of honor will be Dr. Charles P. Berkey, Newberry Professor Emeritus of Geology, who will this year receive the highest honor which our Society can bestow, Honorary Membership.

The charge will be $2.00 per cover, to be collected at the dinner.

Harvard-Yale-Princeton

Harvard-Yale-Princeton alumni will soon receive notices giving the details of their annual reunion held at the time of the Annual Meeting of the Society. The coming reunion will be held on Friday afternoon and evening, January 17, 1941, and will consist of an inspection of the major facilities of the LaGuardia Airport followed by dinner in the Terrace Restaurant. There will be an address by a prominent speaker. Thirty-minute night flights over New York City will be made after dinner. Bus transportation will be provided from some midtown gathering place.

SATURDAY—January 18, 1941

Clarkson College Alumni Dinner

The annual meeting and dinner of the Clarkson College Alumni Association will be held at the Building Trades Employers' Association Club, 26th Floor, 2 Park Avenue, New York, N.Y., on Saturday, January 18, 1941, at 6:30 p.m.

There will also be an informal lunch and an afternoon meeting on the same day in the same place.

Notify Frank C. Boes, 38 Cypress Street, Floral Park, N.Y., as to attendance.

Syracuse University Alumni Dinner

Graduates and former students of the College of Applied Science of Syracuse University will hold an informal dinner at Rutley's, 1440 Broadway, New York, N.Y., at 6:30 p.m., on Thursday, January 23, 1941. Reservations at $1.40 per plate may be secured by writing Reo C. Miles, 29 Grundy Place, Merrick, Long Island, N.Y.

Hotel Accommodations and General Announcements

SANITARY ENGINEERS' MEETINGS, DINNER, AND INSPECTION TRIP

Following is the program of the Thirteenth Annual Meeting of the New York State Sewage Works Association for Friday and Saturday, January 17 and 18, 1941, at the Hotel McAlpin, to which all members of the Sanitary Engineering Division are invited.

FRIDAY—January 17, 1941—Morning and Afternoon

8:30 **Registration—Ballroom, Hotel McAlpin**

10:00 **Annual Meeting**

11:15 **Achievements in Sewage Treatment in New York State During the Past Decade**

EARL DEVENDORF, *Assoc. M. Am. Soc. C.E., Assistant Director, Division of Sanitation, State Department of Health,* Albany, N.Y.

12:15 **Luncheon—The Winter Garden, Hotel McAlpin—Presentation of Awards**

2:15 **The Effects of Sewage Sludge Deposits on the Quality of Streams**

GORDON M. FAIR, *M. Am. Soc. C.E., Professor of Sanitary Engineering, Harvard Graduate School of Engineering,* Cambridge, Mass.

3:00 **Public Relations in the Construction and Administration of Sewerage Works**

CHARLES R. VELZY, *M. Am. Soc. C.E., Works Superintendent, Buffalo Sewer Authority,* Buffalo, N.Y.

3:45 **Operating Experiences at the Riverhead Activated Sludge Sewage Treatment Plant**

RODNEY E. COOK, *Sanitary Engineer, Suffolk County Department of Health,* Riverhead, N.Y., and RAYMOND CORWIN, *Sewage Plant Operator,* Riverhead, N.Y.

4:15 **Present Status of Sewage Treatment in the Boroughs of Queens and Brooklyn (Illustrated)**

RICHARD H. GOULD, *M. Am. Soc. C.E., Acting Deputy Commissioner, Department of Public Works,* New York, N.Y.

4:45 **Adjournment**

FRIDAY—January 17, 1941—Evening

6:30 **Annual Joint Dinner of Sanitary Engineering Division and New York State Sewage Works Association—Ballroom, Hotel McAlpin**

Program—The speaking program will consist of a number of addresses by sanitary engineers on their recent experiences abroad.

Price of tickets $2.50 each.

SATURDAY—January 18, 1941—All Day

9:00 **Inspection Trip in Private Cars to Sewage Treatment Plants in the Boroughs of Brooklyn and Queens**

Leave Hotel McAlpin at 9:00 a.m. sharp. The excursion, passing through the recently opened Queens-Midtown Tunnel, will afford a comprehensive view of the marginal areas of Brooklyn and Queens, Owls Head Sewage Treatment Plant site, Shore Drive, Coney Island Plant, 26th Ward Plant site, Jamaica Plant, Cross Island Parkway, Tallman's Island Plant, Bowery Bay Plant, New York Municipal Airport.

Luncheon at the New York Muncipal Airport.

The return to New York will be made via Grand Central Parkway, Triborough Bridge and East River Drive.

Tickets for the luncheon are $1.25 each.

Hotel Accommodations

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Annual Meeting.

Hotel Rates

Hotels	Without Private Bath		With Private Bath	
	Single Room	Double Room	Single Room	Double Room
Waldorf-Astoria	......	......	$6.00 up	$9.00 up
Astor	......	......	3.50 up	6.00 up
Barclay	......	......	5.00 up	8.00 up
Biltmore	......	......	5.00 up	7.00 up
Chatham	......	......	5.00 up	7.00 up
Claridge	......	......	2.00 up	3.00 up
Commodore	......	......	3.50 up	5.00 up
Edison	......	......	3.00 up	4.00 up
Governor Clinton	......	......	3.00 up	4.00 up
Lexington	......	......	4.00 up	5.00 up
McAlpin	$2.00 up	$3.50 up	3.00 up	4.50 up
Murray Hill	2.00 up	3.00 up	3.00 up	4.00 up
New Yorker	......	......	3.50 up	5.00 up
Pennsylvania	......	......	3.50 up	5.00 up
Plaza	......	......	6.00 up	8.00 up
Roosevelt	......	......	4.50 up	6.00 up
Savoy-Plaza	......	......	6.00 up	8.00 up
Taft	......	3.00 up	2.50 up	3.50 up
Vanderbilt	......	......	3.50 up	6.00 up
Woodward	......	......	2.50 up	3.50 up

NOTE: The Waldorf-Astoria, at which the reception, dinner, and dance will be held, will care for reservations to the extent of its capacity.

Facilities of Engineers' Club

Members may use the dining facilities of the Engineers' Club on a cash basis. Guest cards for this purpose may be obtained at the Registration Desk. The Club will also be able to accommodate a limited number of members, the price of rooms ranging from $2.50 upward. Requests for reservations should be made in advance and addressed to Society Headquarters.

Order Tickets in Advance

Members who order tickets in advance will assist the Committee greatly by giving advance information to guide it in concluding arrangements. Ticket order blanks have been mailed to each member with the condensed program. No cancellation of tickets can be made after noon of Wednesday, January 15, 1941.

Regional Meeting Committee

This program has been prepared under the direction of the Committee on Regional Meetings, GEORGE L. LUCAS, *Vice-President, Am. Soc. C.E., Chairman,* and H. M. LEWIS, H. W. HUDSON, E. P. GOODRICH and LAZARUS WHITE, *Directors, Am. Soc. C.E.*

Committee on Local Arrangements for the Annual Meeting

GLENN S. REEVES, *Chairman*
E. WARREN BOWDEN, *Vice-Chairman*

JOSEPH W. BARKER
F. R. W. CLEVERDON
R. R. GRAHAM
HOWARD L. KING
E. L. MACDONALD
R. R. NACE
ELLIS E. PAUL
ROBERT W. SAWYER, 3D
HOMER R. SEELY
SIDNEY M. SHAPIRO

Junior Members

MORRIS ATKIN
ARCHIE N. CARTER
C. L. DALZELL
SHERMAN GLASS
LAURENCE F. GRANGER
GEORGE G. HAYDEN
A. V. RIZZI
F. C. ROGERS

Ladies Committee

MRS. HOMER R. SEELY, *Chairman*

MRS. E. WARREN BOWDEN
MRS. F. R. W. CLEVERDON
MRS. E. P. GOODRICH
MRS. R. R. GRAHAM
MRS. JOHN P. HOGAN
MRS. OTIS E. HOVEY
MRS. H. W. HUDSON
MRS. HOWARD L. KING
MRS. H. M. LEWIS
MRS. E. L. MACDONALD
MRS. R. R. NACE
MRS. ELLIS E. PAUL
MRS. GEORGE H. PEGRAM
MRS. MALCOLM PIRNIE
MRS. GLENN S. REEVES
MRS. ROBERT RIDGWAY
MRS. ROBERT W. SAWYER, 3D
MRS. GEORGE T. SEABURY
MRS. SIDNEY M. SHAPIRO
MRS. ARTHUR S. TUTTLE
MRS. LAZARUS WHITE

Please call on the Committee on Local Arrangements or on the Secretary's Office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

1940 Prize Winners and Medalists


SHORTRIDGE HARDESTY   HAROLD E. WESSMAN

Norman Medal for Paper, "Preliminary Design of Suspension Bridges"

JOSEPH W. ELLMS

Rudolph Hering Medal for his Work as Chairman of the Committee on Water Treatment Practice, Which Formulated Society Manual No. 19, "Water Treatment Plant Design"

JOHN D. GALLOWAY

Thomas Fitch Rowland Prize for Paper, "Design of Rock-Fill Dams"



EDWARD J. RUTTER   QUINTIN B. GRAVES   FRANKLIN F. SNYDER

J. James R. Croes Medal for Paper, "Flood Routing"

KENNETH D. NICHOLS

Collingwood Prize for Juniors for Paper, "Observed Effect of Geometric Distortion in Hydraulic Models"



A. M. RAWN   A. PERRY BANTA   RICHARD POMEROY

James Laurie Prize for Paper, "Multiple-Stage Sewage Sludge Digestion"

Society Prizes and Medals to Be Awarded

In accordance with its usual custom, the Society will present prizes and medals at its Annual Meeting to be held in New York City, January 15–18, 1941. Of these Society awards the oldest is the Norman Medal, which was endowed in 1872 by the late George H. Norman, M. Am. Soc. C.E., for an original paper that is considered an especially important contribution to the engineering profession. Next in distinction is the J. James R. Croes Medal, established by the Society in 1912 and named for the first recipient of the Norman Medal.

In 1884 the late Thomas Fitch Rowland, Hon. M. Am. Soc. C.E., endowed the prize bearing his name, to be awarded for a paper that best describes in detail some accomplished works of construction. For the paper considered second in merit to that awarded the Thomas Fitch Rowland Prize, the Society in 1912 established the James Laurie Prize, which was named in honor of its first President. In 1924 the Sanitary Engineering Division of the Society instituted and endowed the Rudolph Hering Medal, which goes to the author of the paper adjudged to contain the most valuable contribution to the advancement of the sanitary branch of the profession.

In 1894 the Collingwood Prize for Juniors was established by the late Francis Collingwood, M. Am. Soc. C.E., on his retirement as Secretary of the Society. Papers eligible for this award must describe an engineering work or record an important investigation with which the author has been connected. Excellence of style is also a factor in the selection of the paper receiving this prize.

Norman Medal

Shortridge Hardesty, M. Am. Soc. C.E., was born in Weston, Mo., on September 13, 1884. After graduating from Drake University at Des Moines, Iowa, in 1905 with the degree of bachelor of arts, he attended Rensselaer Polytechnic Institute, receiving the degree of civil engineer in June 1908. He then entered the office of Waddell and Harrington in Kansas City, Mo., continuing with that firm through 1915. He became designing engineer for the firm of Waddell and Son in 1916, and had an important part in the preparation of the manuscript of Waddell's *Bridge Engineering* and *Economics of Bridgework*. In 1920 he came to New York City with Dr. Waddell, in active charge of the latter's office on the design and construction of bridges. In 1927 he became Dr. Waddell's partner in the firm of Waddell and Hardesty, and since Dr. Waddell's death in 1938 has continued the practice under the same firm name. Mr. Hardesty's important bridge work includes the Goethals and Outerbridge cantilever bridges for the Port of New York Authority; the Cooper River cantilever bridge at Charleston, S.C.; the Mississippi River cantilever bridge at Cairo, Ill.; the Anthony Wayne suspension bridge at Toledo, Ohio; the Hudson River lift bridges at Albany and Troy; the North and South Grand Island Bridges over the Niagara River; the new arch bridge now under construction over the Niagara River at Niagara Falls (the longest fixed-ended arch span); the Marine Parkway Bridge over Rockaway Inlet (the longest highway vertical lift span); and numerous other structures throughout the country. He also designed the structural frames of the Trylon and Perisphere for the New York World's Fair, and has made extensive studies relative to long-span cantilever, arch, and suspension bridges, the mechanical and electrical features of movable bridges, and the application of light-weight floors, alloy steels, and structural aluminum to bridge design and construction. He is a member of the Executive Committee of the Society's Structural Division, and a member of the American Institute of Consulting Engineers and numerous other engineering organizations. His fraternities include Sigma Xi, Tau Beta Pi, and Phi Beta Kappa.

Harold E. Wessman, M. Am. Soc. C.E., was born in Rockford, Ill., on December 27, 1899. After graduation from Rockford High School in 1916, he was with the consulting firm of Alvord and Burdick, at Camp Grant, Ill., and with the Winnebago County (Illinois) Highway Department. He was graduated from the University of Illinois in 1924 with the B.S. degree in civil engineering, and in 1925 was awarded the M.S. degree for graduate study in structural engineering and mechanics. In 1929 he was awarded the C.E. degree for his work on the Arthur Kill Bridges. He subsequently returned to the University of Illinois for further graduate study in structural engineering and was awarded the Ph.D. degree in 1936. In 1925 and 1926, he was employed by the South Park Commission in Chicago on the design of lakefront bridges and miscellaneous park structures. He then joined the staff of Waddell and Hardesty, as structural designer on the Arthur Kill Bridges and the Mississippi River bridge at Cairo. In the fall of 1927 he began his teaching career as instructor in civil engineering at the University of Illinois, and in 1929 returned to the firm of Waddell and Hardesty to assist on the Maumee River suspension bridge. Dr. Wessman then went to China with Dr. J. A. L. Waddell, who had been retained as consultant by the China Ministry of Railways. Here he advised in the reorganization of civil engineering in Chiao-Tung University at Shanghai and also taught structural engineering. He left China in 1930, but remained in the New York office of Waddell and Hardesty until 1932. During this engagement he served as co-editor of and wrote several chapters in the book *Vocational Guidance in Engineering Lines*, sponsored by the American Association of Engineers. After further graduate study at the University of Illinois, he served as superintendent of the Rockford (Ill.) Water Department and as consulting engineer to the City of Rockford on utility rates and valuations. In 1934, he became associate professor of structural engineering and mechanics at the State University of Iowa, and in 1937 was appointed professor of structural engineering at New York University, where he is now chairman of the department of civil engineering. He is also engaged in consulting practice. Dr. Wessman is a member of the American Institute of Consulting Engineers and of numerous other engineering organizations and fraternities. He is a captain, Corps of Engineers Reserve, and is active in the affairs of the Metropolitan Section of the Society. He is the author of various technical articles, the most recent being the chapter "Research in Rigid Frames" in the new edition of *The Rigid Frame Bridge*.

J. James R. Croes Medal

Edward J. Rutter, Assoc. M. Am. Soc. C.E., was born in Philadelphia, Pa., on December 13, 1900. He was graduated from Swarthmore College in 1923 with the degree of bachelor of arts in civil engineering, and in 1926 received the degree of civil engineer from the same college. From 1923 to 1927 he was employed by Weston E. Fuller, consulting engineer, as assistant engineer on flood flow studies, reports and appraisals of water supply companies, and water power studies in connection with damage suits for the New York City Board of Water Supply; and as resident engineer on concrete construction. From 1927 to 1932 he was with the U. G. I. Contracting Company, and later, the United Engineers and Constructors, Inc., as engineer on reports, designs, and estimates of hydroelectric and water supply projects; load studies of large interconnected steam and hydro power systems; investigation of storage and power possibilities on the Susquehanna River; and design and construction of an underground electric duct system. In 1933 Mr. Rutter accepted a position with the U.S. Engineer Department (Philadelphia District) at Chesapeake City, Md., on survey calculations for the enlargement of the Chesapeake and Delaware Canal. Since 1934 he has been with the Tennessee Valley Authority at Knoxville in the Water Control Planning Department, and is now senior hydraulic engineer on the investigation and development of flood control problems on the Tennessee River and its tributaries. His work includes backwater curve calculations, flood routing studies for use in planning reservoir operation methods, spillway capacity studies, and studies of past storms and floods. He is a member of the American Geophysical Union.

Quinton B. Graves, Assoc. M. Am. Soc. C.E., was born at Fairview, Okla., on October 23, 1905. Following his graduation from the Topeka (Kans.) High School in 1924, he attended Washburn College at Topeka for one year. His next five years were spent with the Kansas Engineering Company at Topeka—from 1927 to 1930 on a part-time basis while attending the University of Kansas. He received the degree of B.S. in civil engineering in January 1931. He entered the State University of Iowa in September 1930 and received his M.S. degree in June 1932. While at Iowa Mr. Graves was employed as a graduate assistant in the civil engineering department, where he taught surveying and engineering problems. He continued his graduate study until October 1933, when he accepted an appointment as instructor in hydraulics at the University of Tennessee. He left there in 1935 to accept a position as junior engineer with the Tennessee Valley Authority. In 1937 he became instructor in civil engineering at the

University of Texas, which position he holds at the present time. He is a member of Sigma Xi, Alpha Chi Sigma, and the American Water Works Association, and secretary of the Capitol Area Water and Sanitary Association of Austin, Tex. He is author of "Water Power and Flood Control Development," which was published in the *Journal of Architecture, Engineering and Industry*.

FRANKLIN F. SNYDER, Jun. Am. Soc. C.E., was born in Holgate, Ohio, on November 11, 1910, and graduated from Ohio State University in 1932 with a B.C.E. degree. Before graduation and for a period afterwards he made computations and otherwise assisted Prof. C. E. Sherman in preparation of Vol. IV, Final Report, Ohio Topographic Survey. Upon completion of this work he was in charge of the surveying and marking of 65 miles of boundary and the topographic mapping of 5,000 acres of state forest lands for the Ohio Division of Forestry. In 1934 Mr. Snyder accepted a position as junior hydraulic engineer with the U.S. Geological Survey in Washington, D.C., where he assisted in the study of relations of rainfall and runoff, the results of which have been published in Water Supply Paper No. 772. Upon the completion of these studies in 1935 he accepted a position as junior hydraulic engineer with the Tennessee Valley Authority, resigning in 1937 to become hydraulic engineer with the Commonwealth of Pennsylvania at Harrisburg, Pa., where he was in charge of office studies of rainfall and runoff relations in connection with the cooperative hydrologic investigation project of the state, the U.S. Geological Survey, and the U.S. Weather Bureau. Early in 1940 he received an appointment as associate hydrologic engineer with the U.S. Weather Bureau, and shortly thereafter was transferred to Washington, D.C., where he is now in charge of river and flood forecasting in the Division of Synoptic Reports and Forecasts. Mr. Snyder is the author of several papers on various phases of hydrology, among which are "Synthetic Unit Graphs" and "A Conception of Runoff Phenomena," published in the *Transactions of the American Geophysical Union*. He is a member of Tau Beta Pi, Sigma Xi, and the American Geophysical Union, and is a registered professional engineer and surveyor in the state of Ohio.

THOMAS FITCH ROWLAND PRIZE

JOHN D. GALLOWAY, M. Am. Soc. C.E., was born in San Jose, Calif., on October 13, 1869, and graduated from the Rose Polytechnic Institute in 1889 with the degree of bachelor of science in civil engineering. From 1889 to 1892 he was engaged in railroad work in Washington; from 1892 to 1896 he was chief engineer for a contracting firm engaged in general construction; and from 1897 to 1899 was instructor in drawing at the California School of Mechanical Arts. In 1900 he established his own consulting practice, which he maintained for six years. Then (1906 to 1908) he was a member of the architectural and engineering firm of Howard and Galloway, and from 1909 to 1917 of the engineering firm of Galloway and Markwart. During the war Mr. Galloway served as Major of Engineers with the American Army in France, being detailed to service in the G-2 section of the general staff at headquarters. On his return from France the partnership with Mr. Markwart was revived and existed until the end of 1920. Since then Mr. Galloway has maintained a consulting practice in San Francisco, his work including hydroelectric construction in the West and British Columbia, irrigation work in California, and numerous other projects. He is a member of various engineering and general societies, and is the author of several papers that have appeared in the publications of the Society and other organizations. In January 1940 he became a Life Member of the Society, and in October was elected an Honorary Member. A more detailed biographical sketch of Mr. Galloway's career appears in this issue under the head of "Honorary Membership Awarded to Five Engineers."

JAMES LAURIE PRIZE

A. M. RAWN, M. Am. Soc. C.E., was born in Dayton, Ohio, on November 2, 1888, and received his formal education in the public schools of Toledo. From 1905 to 1909 he was employed by the Illinois Central Railroad Company, and from 1910 until the World War by the U.S. Reclamation Service on the Yakima Project in Washington, the Boise and King Hill project in Idaho, and the Salt River Project in Arizona. At the outbreak of the war, he enlisted in the 319th Engineers, and subsequently was transferred to an assignment as first lieutenant, 605th Engineers, A.E.F. At the close of the war he returned to a position as construction engineer on the King Hill Project in Idaho, was promoted to the position of project manager in 1920, and upon completion of the construction of that project he was transferred to assist in an investigation of the proposed Columbia Basin Project in Washington. Mr. Rawn resigned from the Bureau of Reclamation upon the completion of the Columbia Basin assignment and, in 1924, entered the service of the County Surveyor of Los Angeles County, California. Upon the formation of the County Sanitation Districts of Los Angeles County he was appointed assistant chief engineer, serving in that capacity until September 1940 when he was appointed chief engineer and general manager. Mr. Rawn is a member of the American Society of Civil Engineers, the Society of American Military Engineers, and the California Sewage Works Association, and has served as president of the latter organization and of the Los Angeles Section of the Society. He is an associate editor of *Water Works and Sewerage* and *Western City*, and has published a number of articles dealing with sanitation in the United States.

A. PERRY BANTA, Assoc. M. Am. Soc. C.E., was born in New York City on June 29, 1904. He received his preparatory education at Mount Hermon School and later entered Stanford University, receiving the degree of A.B. in C.E. in 1926. He was appointed teaching fellow at the California Institute of Technology and in 1928, upon completion of his graduate study, was awarded the degree of M.S. in C.E. Prior to 1927 he filled a variety of minor engineering positions with the Great Western Power Company; the U.S. National Park Service; Blaine and Cascade Counties, Montana; the Pacific Coast Steel Company; the Southern Pacific Railroad; and Thebo, Starr and Anderton, consulting engineers. In 1927 he served as consultant for the Celite Company and for the Los Angeles Harbor Investigating Board, and as designing engineer for Quinton, Code and Hill, consulting engineers. Since then he has been successively assistant sanitary engineer and sanitary engineer for the Los Angeles County Sanitation Districts, engaged in design and research on various problems of the metropolitan area. From 1938 on he has, also, been assistant professor of sanitary engineering at the California Institute of Technology, dividing his time between the two positions. He is the author of numerous articles reporting results of research on sewage transportation and treatment. Mr. Banta is a member of the American Water Works Association, the California Sewage Works Association, and Sigma Xi.

RICHARD POMEROY was born in Burbank, Calif., on December 22, 1904. He attended California Institute of Technology, where he distinguished himself not only scholastically but in forensics and athletics as well, becoming a member of the All-American Track Team in 1930. He received the degree of B.S. with honor in 1926, M.S. in 1927, and Ph.D. in 1931. Honor societies to which he belonged were Tau Beta Pi, Pi Kappa Delta, and Sigma Xi. He held fellowships for research on gas analysis, and on petroleum production problems. From 1927 to 1931 he served as an instructor in chemistry at the University of California at Los Angeles. After finishing his graduate studies, Mr. Pomeroy joined the staff of the Los Angeles County Sanitation Districts as research chemist, which position he held until May 1940. He is chairman of the Fact Finding Committee on Design Standards of the California Sewage Works Association, and a member of the Committee on Standard Methods of Analysis to assist in publication of the American Public Health Association manual on Standard Methods for Analysis of Water and Sewage. He devised the LaMotte-Pomeroy sulfide testing equipment, and is the originator of potentiometric control of chlorination. Many articles from his pen have been published on methods of sewage treatment, methods of analysis, corrosion, and other subjects. He is now associated with James Montgomery in the firm of Montgomery and Pomeroy, offering consulting and designing services in water, sewage, and industrial waste problems.

RUDOLPH HERING MEDAL

JOSEPH W. ELLMS, M. Am. Soc. C.E., was born at Ayer, Mass., on October 4, 1867. His technical education was received at the Massachusetts Institute of Technology during the years 1890 to 1892. From 1893 to 1896 he was assistant in the laboratories of the Massachusetts State Board of Health, and in 1896 he was a member of the staff of engineers and chemists who conducted the basic studies on water purification at Louisville, Ky. In 1897 he was appointed chemist for the Brooklyn (N.Y.) Department of Health. Water filtration experiments at Cincinnati, Ohio, took him there in 1898, and following the completion of this work in 1899 he remained as engineer of tests and research for the next nine years, during the building of Cincinnati's new water works. During this period, he developed the high velocity method of washing

rapid sand filters, and made studies of strainer systems and other features of design. From 1908 to 1918 he was in charge of the operation of the new Cincinnati rapid sand filter plant, one of the first large plants of its type in the country, and also spent part of his time in general consulting work along sanitary engineering lines. In 1918 he placed Cleveland's first water filtration plant in operation, and for the next 14 years was actively engaged in consulting engineering work for a number of the large cities of the country. In 1920 he conducted an experimental investigation of processes for the purification of Lake Michigan water for the City of Milwaukee, and from 1920 to 1924 designed and constructed a new water works system for Bay City, Mich. As consulting engineer for the City of Cleveland, he was associated in the design and construction of the city's second large water filtration plant and covered filtered water reservoir. While on this work he developed the hydraulic jump mixing flume, which has proved to be a valuable device for the rapid mixing of chemical coagulants with the water to be treated. In 1932 Mr. Ellms became sanitary engineer of the Department of Public Utilities of Cleveland, and since 1937 has been commissioner of the Division of Sewage Disposal of this department. He is the author of a book entitled *Water Purification* and of many papers and reports on technical subjects. He is a member of numerous engineering and scientific organizations. He became a member of the Society in 1913 and a Life Member in 1938.

Collingwood Prize for Juniors

Kenneth D. Nichols, Jun. Am. Soc. C.E., was born in Cleveland, Ohio, on November 13, 1907. He was graduated from the U.S. Military Academy in 1929 and from the Engineer School at Fort Belvoir, Va., in 1937. He also received the degree C.E. and M.C.E. from Cornell University in 1932 and 1933, and the Ph.D. degree from the State University of Iowa in 1937. Upon graduation from the Military Academy he was commissioned a second lieutenant in the Corps of Engineers, U.S. Army, and later promoted to first lieutenant and captain. His first duty in the Corps of Engineers was assignment to the U.S. Army Engineer Battalion in Nicaragua, and he spent the period from 1929 to 1931 in surveying the route for the proposed Nicaraguan Canal. During the periods 1933 to 1934 and 1935 to 1936 he was assistant director of the U.S. Waterways Experiment Station at Vicksburg, Miss. In the fall of 1934 he was awarded a fellowship by the Institute of International Education and assigned to duty in Berlin, where he studied at the Technische Hochschule. He also visited most of the leading hydraulic laboratories in Europe. Since 1937 he has been an instructor in the Department of Civil and Military Engineering at the U.S. Military Academy. Captain Nichols is a member of Sigma Xi and the Permanent International Association of Navigation Congresses, and is the author of several articles and discussions dealing with hydraulic models.

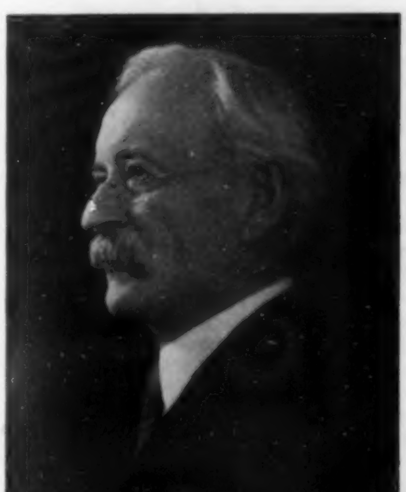
Honorary Membership Awarded to Five Engineers

Sketches of Men Eminent in the Profession Who Receive This Distinction at 1941 Annual Meeting

CHARLES P. BERKEY

Who would not be gratified to have a wide reputation as scholar or explorer, teacher or consultant, lecturer or engineering geologist? Charles P. Berkey, recent recipient of honorary membership in the Society, is not only one, but all of these. And in each role he has been eminently successful.

Leaving Indiana, where he was born, he obtained his academic training at the University of Minnesota, which bestowed upon him his bachelor's, master's and doctor's degrees. He also received an honorary doctorate from Columbia University. For ten years following graduation, he was instructor in mineralogy at his alma mater. Beginning in 1903, he served Columbia University successively as tutor, instructor, assistant professor, associate professor, and professor. Since 1939 he has been Newberry Professor Emeritus of Geology there.



Charles Peter Berkey

This brief outline does not tell half the story. His other activities have literally extended throughout the world—geological surveys in Minnesota, Wisconsin, and New York, studies in Puerto Rico, and exploratory field work in the deserts of Central Asia. Most of the great engineering projects of recent years in the United States have had the benefit of his advice on foundation and excavation problems, including the New York and Boston Aqueducts; bridges and tunnels for the Port of New York Authority; the Colorado River Board (Hoover Dam); the State of California and the City of Los Angeles on the San Gabriel and other projects; Safe Harbor and Conowingo projects on the Susquehanna; Fifteen-Mile Falls Dam on the Connecticut; and many other projects for the Bureau of Reclamation, for the U.S. War Department, and for the Tennessee Valley Authority.

At least fifteen scientific organizations count him among their members, including this Society and the American Institute of Mining and Metallurgical Engineers. He has been president of the New York Academy of Science, and since 1922, secretary of the Geological Society of America.

In part, the explanation of this marvelous record goes back to his early life. As a boy, he had the enviable advantage of working on a farm. He knew a farmer's contempt for the clock. He could ride anything that had a back to sit on. He could mend machinery promptly and effectively, knowing that farm work must be done exactly when crops required; knowing, too, that replacements and expert help were alike out of the question and that he had only few and simple tools. He has a naturally serious mind, inherited from puritan forbears who cared more for principles than for convenience.

He may look spare and frail but he performs wonders of quiet endurance and unheralded courage. One night, while on the exploration of the American Museum of Natural History in the Gobi Desert, after a long day in a mountain range, he came back to camp to find the Chinese cook in a panic of apprehension over his delayed return—calling and waving a lantern but not daring to stray far from the camp. It was nearly midnight; but as soon as Dr. Berkey had eaten, he lit his candle and sat down to work up his day's notes—he never neglected them—as unweariedly as though he had not just put in an eighteen-hour day. On another occasion after a hard day, his only comment, as he got off his camel, was that the beast rode as if it had been assembled out of a lot of spare parts.

In reply to a friend's expression of amazement at his capacity for work, Dr. Berkey remarked, "I don't get tired; but I do get headaches." A combination of enthusiasm, endurance, indomitable will, remarkable constitution, and profound geological knowledge is his stock in trade. So it was not an accident that the honor of finding the first fossil in the Central Asia exploration went to him.

As a teacher of geology, Dr. Berkey has commanded the admiration and affection of thousands of students. They love the genial, often half-humorous, whimsical way in which he drives home fundamental principles. His gestures, his voice, and his illustrations are part of an effective whole. One of his characteristic procedures, after discussing a complicated problem, is to lean toward the class and say with an engaging smile, "It's just as simple as that." This has become a byword and his students once wove that sentence into their college yell—in honor of Dr. Berkey.

On the personal side, he is a lover of music although he appre-

ciates it intellectually rather than emotionally. He reads good biography and history but never a novel. His impatience with novelists is only exceeded by his distaste for poets. He feels that the valuable thing is the basic idea, not the words which express it. "Scientists and engineers don't write their reports in verse because they know their thoughts are worth reading in prose. I see no excuse for poetry." His sincerity is so genuine that he cannot bear an artificial statement. "I confess," he once said, "that the one kind of man I can't bear is the artificial man."

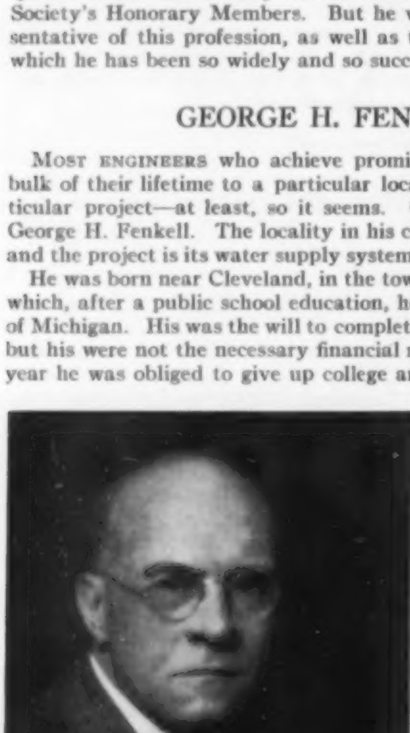
With a deep belief in a simple, unformulated religion, he helped to found a church in his community of Palisades, N.J. He has fought for clean politics and for the fundamental principles of democracy. Something of an ascetic, he neither smokes, drinks, nor swears.

His hobby, if he has one, is gardening—an old boyhood skill that has come again to the fore. He holds deep, strong friendships which never lessen. And he has a delightful sense of humor, expressed in wholly original thought—never in remembered or quoted tales. Dr. Berkey will be the only geologist among the Society's Honorary Members. But he will make an ideal representative of this profession, as well as that of engineering, with which he has been so widely and so successfully associated.

GEORGE H. FENKELL

MOST ENGINEERS who achieve prominence have devoted the bulk of their lifetime to a particular locality and often to a particular project—at least, so it seems. Certainly this is true of George H. Fenkell. The locality in his case is the city of Detroit and the project is its water supply system.

He was born near Cleveland, in the town of Chagrin Falls, from which, after a public school education, he went to the University of Michigan. His was the will to complete the engineering course, but his were not the necessary financial resources. After a single year he was obliged to give up college and to forego any further formal education. But he did receive a practical training in engineering of a high caliber, which was recognized by the University of Michigan in 1926, when it acknowledged his high accomplishments as an engineer by granting to him the degree of Bachelor of Science in Engineering, *nunc pro tunc*, dating it back to his original class of 1895.



GEORGE HARRISON FENKELL

For a few years he did routine engineering work on railway locations and for five years early in the century he served as civil engineer for the city of Erie, Pa., on its water supply. But otherwise his professional work was performed solely for the city of Detroit, largely in connection with its water supply. This included the year 1894 when he served as draftsman, and the years 1896 to 1902, during which he progressed to the position of chief draftsman. After the previously mentioned interim in Erie, Pa., he returned to Detroit for good in 1908—but not to the same position, of course.

His progress was rapid, and in 1913 he was drafted as commissioner of public works for the city. In this position, in spite of the interruption of the World War, he built more than 200 miles of sewers and paved over 300 miles of streets. The department was completely rehabilitated. The Belle Isle Bridge was designed and built, and other public works costing more than 20 million dollars were carried through to completion.

When a new city charter was adopted in 1918, Mr. Fenkell was made general manager of the Department of Water Supply. Under him, during the succeeding twenty years, a vast program was undertaken, involving the institution of a meter system, the construction of what was at that time the largest rapid sand filtration plant in the world, and further improvements in filtration that culminated in the completion of the renowned Springwells Station in 1933. The magnitude of his accomplishment is best indicated by the fact that when he became general manager of the Department of Water Supply in 1918 he found an inadequate plant valued at $18,000,000, serving 900,000 people, and when he resigned after twenty years, he left a modernized system representing an investment of over $130,000,000 and serving a population of 1,800,000.

On the side, so to speak, he served on the city's Recreation Commission for a number of years. He was also a member of the celebrated Engineering Board of Review of the Sanitary District of Chicago, in 1924 and 1925. For several years, also, he held a commission as lieutenant colonel in the Corps of Engineers Reserve. In a professional way he has been active in the Michigan Engineering Society, the Detroit Engineering Society, and the American Water Works Association. Recently (1940) he was made an honorary member of the latter body.

As a Director of the Society from the Seventh District for the term 1923–1925, he took a keen interest in all his official duties. It was his custom, after each quarterly meeting of the Board, to forward to members in his District a circular letter informing them of salient accomplishments. Besides being actively interested in his own Local Section, he made numerous official trips to other parts of his District.

In building up an organization to design and construct the additional water supply for Detroit, Mr. Fenkell put into practice many advanced ideas. One of these was to open the civil service examinations to men from outside the city. As a result of his efforts, examinations were held in some twenty cities throughout the country. Only those candidates whose ratings were sufficiently high were required to come to Detroit for oral examination and conference. Not only did this method save considerable expense, but it undoubtedly accounted for the exceptionally fine staff of assistants which he secured. To promote cooperation and good feeling, he arranged for weekly luncheons with his key men, thus keeping everyone informed of progress and of mutual problems. Informality was the rule, and frequently officials of other city departments were guests.

Largely as a result of his attitude, a fine tradition and esprit de corps were engendered. He was often heard to say that all relations between superiors and subordinates should be so conducted as to convince those concerned that their associations with the department had been advantageous, both as individuals and as employees. He had the reputation for accurately sizing up the capabilities of subordinates. Once having satisfied himself on this point, he allowed them a free hand, with only sufficient supervision to insure the desired result. To this end, he took pains to be always accessible for consultation and advice.

In his social contacts, Mr. Fenkell always enters into the spirit of the occasion. At staff parties he did his share to make the gathering a success. Once at a Christmas party of employees he was solemnly presented with a bag of hay instead of smoking tobacco; he gravely accepted the gift with the remark that it was his favorite brand. He loves to entertain his friends at his farm outside Detroit. In this connection allusion should be made to his reputation for cooking a very palatable steak over an outdoor fire.

Associations in Society work, particularly when he was Director, gave Mr. Fenkell a wide acquaintance. These engineers, together with a host of friends around Detroit, will join in felicitating him as he is invested with the highest honor in the profession.

JOHN D. GALLOWAY

TRACING his ancestry back to the Atlantic seaboard and to the stirring days before the Revolution, John D. Galloway claims the distinction of having been born in California—San Jose, to be exact, in 1869. Most of his important life work has been carried on in this vicinity—in nearby San Francisco.

Left to his own resources at an early age, he acted as a telegraph messenger in Virginia City, Nev., when it was the center of the great mining activity that followed the discovery and development of the famous Comstock Lode. Under these surroundings one of his dominant characteristics, self reliance, early came to the fore. It has stood him in good stead.

His technical education was gained, but not without some financial struggles, at Rose Polytechnic Institute, Terre Haute, Ind. There originated lifelong friendships with others who later became leaders of the Society. He graduated with the class of 1889. We next find him engaged in railroad work in the Pacific Northwest. Recalling these days he enjoys telling of a good turn received at the hands of John F. Stevens, Past-President and Honorary Member of the Society, when, without meeting him and through a consolidation of railroad interests, Mr. Stevens released Mr. Galloway to what later proved to be better and more congenial employment.

John Debo Galloway

After a short period in the Pacific Northwest, Mr. Galloway returned to California and has ever since maintained his headquarters in San Francisco although his practice has often taken him far afield. As one of his contemporaries, himself a past officer of the Society, recently said, "He has had a hand in almost every major engineering project in northern California during the past forty years."

Since 1900 he has been continuously in private practice. Following the San Francisco earthquake and fire, his firm designed and supervised the construction of many of the city's important buildings. In spite of the incessant demands of this busy period he found time to aid in revising the San Francisco Building Code, to assist in relief work, and to perform many other civic duties.

In 1917 Mr. Galloway's practice was rudely interrupted by World War No. 1. He became chairman of a temporary organization of about 750 engineers for the study of war work and for supplying information preparatory to army service. In November he was called to service and ordered to France. He served as Major of Engineers in G-2 Section of the General Staff at the headquarters of the American Expeditionary Force at Chaumont. For this service he received a citation from General Pershing. He was discharged at Washington, D.C., in January 1919.

His private practice has included many important buildings and bridge projects, power plants, irrigation works, and valuations. To mention but a few, there were the San Mateo Bridge project; the Stanislaus, Las Plumas, and Moccasin hydroelectric plants; the great Shasta Dam now being built; and the Coyote Dam of the Santa Clara Valley Water Conservation District. On the first commission for the location of the now famous San Francisco–Oakland Bay Bridge he was one of a distinguished group, serving with Robert Ridgway and A. N. Talbot, both Honorary Members of the Society, as well as with M. M. O'Shaughnessy, long city engineer of San Francisco.

He has written a number of authoritative articles, especially for the Society. His paper on "Rockfill Dams" is receiving the Thomas Fitch Rowland Prize, and in that connection another item appears in this issue covering further details of his engineering work. Mr. Galloway therefore presents the unusual picture of one who at the same Society meeting is receiving one of the Society prizes, customarily granted to much younger men, and honorary membership, always awarded to the "elder statesmen" group. The dual honor is a significant tribute to the depth and catholicity of his interests.

Among many important assignments that he has filled for the Society one stands out in bold relief, his chairmanship of the Society's Earthquake Committee, which was instituted following the Japanese disaster of 1923. After years of study this committee produced a monumental report, which is still consulted for authentic information on a wide variety of earthquake problems.

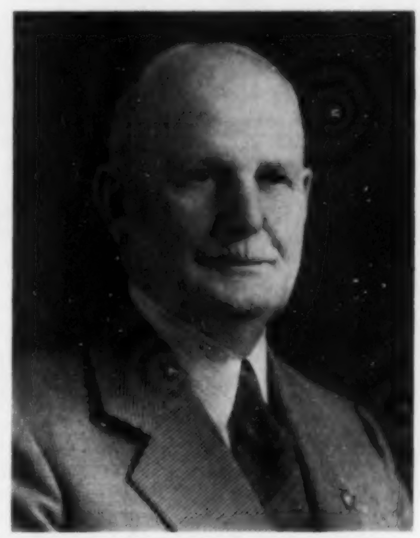
He is a charter member and past-president of the San Francisco Section, and has similarly served many other technical and social groups. He is a charter and life member of the Commonwealth Club of California, and a past-president of the board of directors of the California School of Mechanical Arts. San Francisco's noted Bohemian Club, a group of professional and civic leaders, has learned to appreciate his ability, for he has frequently had charge of its summer retreat in the heart of the Redwood country, managing events that have become famous for their originality and convivial atmosphere.

Outside of his professional practice, Mr. Galloway's life has been richly filled with varied interests. He has a passionate fondness for historical research, particularly when it relates to the early development of the West such as the Pacific Railroads, the utilites which served the western mining regions, and early explorations in general. He has made a fine collection of rare prints. He and Mrs. Galloway also take much pleasure in gardening. Needless to say, their grandchildren always find a warm welcome in the Galloway home.

With a capacity for genuine friendship, Mr. Galloway when occasion demands, can be a frank critic. Whatever the decision his logical mind leads him to take, he defends it strongly; he is nobody's "yes man." This independence, combined with his kindliness and his gift of common sense, has made him greatly admired and beloved. His many friends in the San Francisco district and elsewhere will rejoice in the distinction that now comes to him in the form of honorary membership in the Society.

FRANK G. JONAH

In past years the Society has been privileged to include many foreign engineers in its roster of Honorary Members. But Frank G. Jonah cannot be put in this category—he has been for many years an American citizen. He was born in New Brunswick, Canada, in 1864, and received his education to and including high school at Moncton, New Brunswick. Thenceforth, his training was by private tuition and instruction connected with his engineering experience.



Frank Gilbert Jonah

In accordance with the customs of the day and the locality, he became a "student" in the chief engineer's office of the Intercolonial Railway at Moncton. This road is now a part of the Canadian National Lines. In reality, his three-year term was an apprenticeship, following somewhat the accepted practice in England at that time. It brought him diversified experience, as he fulfilled the duties of chainman, rodman, levelman, and transitman on surveys for branch lines.

He is one of those who have never lost the love of railroading; it has been his life work. He progressed rapidly. In September 1887 he became resident engineer in charge of construction of government railways in Nova Scotia. Transferring his residence to the United States, he settled in St. Louis, where he still makes his home. In 1890 he became assistant engineer on the St. Louis Merchants Bridge Terminal. There he came under the direction and tutelage of the chief engineer, the late Robert Moore, Past-President of the Society. This association lasted for eight years, four years in Mr. Moore's office and four years representing him on the construction of lines in Illinois. It was an interesting period and yielded fruitful experience for the young man. That Mr. Jonah fully appreciated this is evidenced by the Society's memoir of Mr. Moore, of which he was a joint author. He must have had himself in mind when he mentioned "many young men entering the profession, whose success is due in large measure to the inspiration of his [Moore's] example and whose associations

with him will always remain among their most cherished recollections."

So it happened that, with this auspicious beginning in American railroading, he continued in this field. He has personally made the locations for nearly 2,000 miles of railway line and has been in charge of the construction of 1,000 miles. To enumerate all his connections would be superfluous. It should be mentioned, however, that since 1901 he has been associated with only one line—the Frisco System. In January 1910 he became chief engineer of construction, and since 1913 has been chief engineer of the entire system, now comprising 5,300 miles.

In the World War his record was notable. He was largely instrumental in recruiting the 12th Engineers, a voluntary regiment of railroad workers organized in St. Louis. Going overseas with this regiment as major, he saw active service on the British front in Picardy from August to November 1917. The American Army then organized its own department of Light Railways and Roads, in which Major Jonah became Chief Engineer of the Light Railways. In this position he had the good fortune to serve under General Jadwin, later Chief of Engineers, U.S. Army. It was under these circumstances that he planned most of the light railways built by the American Army, rising to the rank of lieutenant colonel. He was honorably discharged in 1919. For his work in France he received a Headquarter Citation for "Exceptionally Meritorious and Conspicuous Services," also a special letter of commendation from General Pershing. For the Headquarters Citation he was later awarded the medal of the Order of the Purple Heart.

In 1920 Colonel Jonah was honored by General Haller, the official representative of the Polish Government, by being awarded a diploma and medal for his services during and after the war. On returning from his service overseas, he immediately resumed his duties on the Frisco Railway as chief engineer.

In his home city of St. Louis, Colonel Jonah has been very active in civic affairs. He has served on numerous honorary committees, such as those having to do with the Soldiers Memorial Building, the City Building Code, and a survey for a comprehensive terminal.

Because of his achievements and his personal popularity, he has been prominent in many organizations. He holds charter membership in the American Railway Engineering Association and in the Society of American Military Engineers. Of the latter he was president in 1931. He was instrumental in stirring the St. Louis Section of the Society into renewed activity. In 1917 he served as president of the Engineers' Club of St. Louis. A member of the Society since 1903, he was elected a Director in 1916, but resigned the following year on his departure for France. In 1933–1934, he gave splendid service as Vice-President from Zone III, including work on important committees of the Board of Direction.

In the historical field, he is an authority on the life of Robert Burns and on his poems, and is a member of the Burns Club of St. Louis. A Shakespeare enthusiast also, he is on terms of familiarity with all the plays of this great author. Another interest is the history of transportation, on which he has done much research, from the time of primitive man down through the successive stages of drags, dugouts, and wheels to the perfection of modern transport. As a student of archeology, he has lectured on the Pyramids; he loves to explain how the gigantic 1,400-ton granite pieces were placed in position through the use of sand funnels.

For recreation he has taken up golfing and tramping, and what with these activities and his wide circle of friends, he never lacks entertainment. By nature he is most sociable—a jovial host and a convivial companion. He enjoys a well-earned reputation as a story-teller. No one better than he knows and appreciates good food and its concomitants. To be entertained in his private car is a treat indeed.

A faithful attender of Society meetings, his ready smile and friendly greeting will be found wherever members gather. His room is always a center of good fellowship. Because of his ability, wisdom, and understanding of human nature, he enjoys to a rare degree the complete confidence of his superiors, the affectionate respect of his equals, and the loyalty of his subordinates. Colonel Jonah will be warmly welcomed into the distinguished group of Honorary Members.

REGINALD H. THOMSON

PERHAPS AS much as to any other living engineer, the Puget Sound region is indebted to Reginald H. Thomson. After a long, busy, and profitable practice in this area, he can look back on its development with great satisfaction.

So long has he been identified with engineering accomplishment in this section that it seems he must have spent his whole life there. On the contrary, he was born, brought up, and trained in the Hoosier State. Born in 1856 in Hanover, Ind., he remained there until his graduation in arts from Hanover College in 1877. (Later the college gave him a Ph.D. degree.) Then he "went west," where he has remained ever since. First he studied engineering and taught in California. From 1881 on, his work has been in the state of Washington.

As early as 1884, Mr. Thomson became city surveyor of Seattle. Two years later he entered the railroad field, first on work in the Cascade Mountains, then in Spokane, then on a projected line across the Olympic Peninsula. For some years he was U.S. Deputy Mineral Surveyor, devoting his time to surveys, mining examinations, and reports.


REGINALD HEBER THOMSON

In June 1892, with a recognized reputation, he again entered the service of Seattle, this time as city engineer. For a period of almost twenty years this work absorbed his energy and benefited from his vision. From a straggling railroad and seaport town, he saw Seattle grow into a great metropolis. And his was one of the prime efforts in that growth. Undoubtedly, it was the major work of his career. At the turn of the century, the city found its development checked and hampered by the difficulties of local terrain, by steep hills that blocked important streets, and by deep ravines that lay along the course of needed thoroughfares. It took constant vision and imagination to foresee the benefits to accrue from proper street grades. It took excavation of heroic proportion to accomplish this, the necessary cuts ranging from 4 to 140 ft in depth. It took regrading amounting to over 16 million cu yd of earth, which was placed on tidelands in the south part of the city, raising and stabilizing the surface of several hundred acres of land and making it the most important manufacturing center of Puget Sound. More than this, it took boldness and courage to obtain cooperation from a none-too-willing city council, against the protests of anguished property owners who anticipated ruin from the heavy assessments entailed.

This was spectacular work, but it was not his only work. Mr. Thomson introduced concrete walks and hard-surface pavements; he took the lead in securing watershed land and designed and built a system yielding a potential supply of 400 mgd of clear mountain water. From Congress he helped secure funds for building the Salmon Bay Locks controlling the Lake Washington Ship Canal; under his direction the Cedar Falls hydroelectric power plant was built. On two separate occasions he spent months in Europe studying city growth and government. As a result he was instrumental in pressing through the state legislature laws authorizing the establishment of the Port of Seattle.

This matter of port development was one of Mr. Thomson's pet projects. In order to further develop his ideas he resigned his position as city engineer, to organize the port. This done, he turned it over to others and left Seattle temporarily to work under the cabinet of British Columbia, until the World War interrupted. But he could not stay out of work developing his home city. From 1916 to 1921 Mr. Thompson was a member of the City Council; again in 1930–1931 he was city engineer of Seattle. In the interim he did work in Alaska; he studied the railroad freight situation in Seattle; he was consultant on the Rogue River Irrigation Canal; he designed and built a new hydroelectric plant for Eugene, Ore.; he was consultant at Bellingham, Wash., and at Wenatchee; he was also consultant on the early studies for the

Mud Mountain Dam, consultant for the Lake Washington Floating Bridge, and for the foundations of the Tacoma Narrows Bridge.

But he has not confined himself to strictly technical matters. He has been president of the Pacific Northwest Society of Civil Engineers. For ten years, 1905–1915, he was president of the board of managers of the University of Washington. He was director of the Society for the term 1917–1919.

Speaking of the days of his active service, one of his long-time trusted employees called him a "workhorse." He was devoted to his duty, and he demanded the same loyalty and devotion from all his subordinates. He had knowledge of details and he knew where or from whom he could obtain whatever information he did not himself possess. If he deemed an improvement to be to the major interest of the city, "R. H." was for it with unchanging will and resolution, shrewdly foreseeing opposition before it developed, and as much as possible forestalling it. Of him more than of any other one man it can be said that he shaped and fashioned Seattle.

At the age of 84, R. H. Thomson is a hale, vigorous, active man. To a youngster who observed to him how remarkably well preserved both his physical and mental faculties were, he promptly replied: "And do you know why? Because I have always used them." That same use of his faculties, fully and energetically, has been a notable characteristic all his life. Whatever he has done, he has done with complete interest and energy.

If he ever takes time to look around him, it must be with deep satisfaction. His efforts, his struggles, are fully rewarded by the result. Seattle is a great and growing city, in generous measure due to his efforts. His new title of Honorary Member is only a token, although a significant one, of the esteem in which his fellow townsmen and his engineering associates hold him.

Stress Specialties for Army Service

By this time, all of the Society's Juniors and as many Corporate Members as have not attained their 36th birthday or who are not already in the armed services, will have been registered in accordance with the Selective Training and Service Act of 1940. The President has authorized the selection by July 1 of 1941, for a year of training and service, of a total of 925,000 of those who have registered, and local draft boards now are making the required selections.

Great care is being taken in the draft questionnaires and in the operation of the draft board to secure classifications of selectees so that they will be assigned to units where their experience, education, and training will be of greatest use to the government. It is important therefore that every civil engineer who is selected be sure to indicate his special qualifications and experience.

Most of the engineers, draftsmen, designers, or surveyors selected by the draft will probably be assigned to the Corps of Engineers, whose many duties include bridging, railway construction, water supply, and other engineering specialties. Some will be needed in such other branches as the Ordnance Department, Signal Corps, and Quartermaster Corps. As General Schley has emphasized in his article, "Role of the Engineers in Warfare," on page 15 of the present issue, the current organization of the army requires the use of engineer troops to a much greater extent than formerly.

In accordance with a recent action of the Board of Direction, members of the Society who have volunteered or are selected to serve their country in non-commissioned grades of the armed forces of the nation will be eligible for exemption from the payment of Society dues for the period of national service. Each exemption must be requested on a form to be obtained from the Secretary.

Valuable Earthquake Data Filed

A detailed report on earthquake action was filed some years ago in the Engineering Societies Library. This was prepared by the Society's former earthquake committee, which worked for a number of years following the Japanese catastrophe of 1923. The committee has now added to this report a large file of supplementary papers, gathered during the course of its extensive studies. For the most part it comprises a valuable group of Japanese reports that had been held for reference by the committee's chairman, J. D. Galloway, in San Francisco. The combined data, now available in the Engineering Societies Library, provide a fruitful source of information, engineering and historic.

Lincoln Bush, 1860–1940

In the death of Lincoln Bush, Past-President and Honorary Member, which occurred on December 10, the Society loses one of its most distinguished and lovable members. If Colonel Bush had lived four days longer, he would have been 80 years old. His funeral in East Orange, where he made his home for many years, was attended by a number of present and former Society officers and members of the staff, the latter because he had worked with them for a period as temporary Secretary.

Most of his work was in railroad and consulting engineering; but in the World War he was active in the Quartermaster Corps, where he gained the title of Colonel by which he was always known thereafter.

Lincoln Bush, 1860–1940

After graduation in 1888 from the University of Illinois, from which he subsequently received an honorary doctorate of engineering, he was employed on various railroad, bridge, and construction projects until he was called East in 1899 by the Delaware, Lackawanna & Western Railroad. Shortly afterwards he became chief engineer, which position he held for six years. From 1909 on he maintained a successful consulting and contracting engineering practice. He was inventor of the Bush train shed, widely used by railroads in this country and abroad. During the war, Colonel Bush was responsible for the design and operation of seven terminal ports on the Atlantic and the Gulf of Mexico, the total value of the work under his charge being over $200,000,000.

Beginning in 1912, he was active in the affairs of the Society. He had the unprecedented distinction of holding every elective office—he was successively Director, Vice-President, and President; he also acted as Treasurer for one or more terms and, upon the death of Secretary John H. Dunlap, he served unofficially as Secretary for a few months. In the financial affairs of the Society he was a tower of strength, frequently being referred to lovingly as "The Watch-Dog of the Treasury." As chairman of the Committee on the 57th Street Property, he was of tremendous help in the negotiations leading up to its successful rental at a figure which, since 1926, has made possible many developments within the Society.

Colonel Bush's unending labors for the Society, his great success in all that he undertook, his fine character, and his friendly personality made him an outstanding figure, not only as President but as Honorary Member. No one of his generation gave more generously or more effectively to promote the best interest of engineers and of the Society.

Horizontal Control Surveys Featured in New Society Manual

Placed in the mail during December, Manual of Engineering Practice No. 20, prepared by the Committee on Control Surveys of the Society's Surveying and Mapping Division, should have already reached most of the membership.

Under the title, "Horizontal Control Surveys to Supplement the Fundamental Net," the committee has emphasized ways and means of facilitating the tie-in of local surveys with the nation-wide triangulation net. In 1933, the U.S. Coast and Geodetic Survey published tables for State Systems of Plane Coordinates, and the subsequent establishment of hundreds of traverse stations throughout the United States has made geodetic control available for general use for the first time. More such stations are needed; and the agencies of federal, state, county, and municipal governments; engineers and officials of private land corporations; private engineers and private land surveyors are all engaged in the work.

The manual is designed to introduce the method of expanding the fundamental net to persons not intimately familiar with the procedure. It covers all the operations and information and should provide a complete handbook for establishing traverse.

The number of supplementary references required to explain all the field operations has been reduced to four instead of the previous complicated and overlapping list.

The manual was formally adopted by the Board of Direction on December 4, 1939. It has been reviewed and revised by specialists of the U.S. Coast and Geodetic Survey and others and represents the best composite opinion of the most eminent geodetic engineers in the country. During the preparation of the manual, the members of the committee were: Philip Kissam, Assoc. M. Am. Soc. C.E., chairman; E. A. Bayley, H. W. Hemple, R. H. Randall, J. G. Staack, R. L. Sumwalt, and C. J. Tilden, Members Am. Soc. C.E.; and O. de La V. Keese, Assoc. M. Am. Soc. C.E. (in 1939).

Life Memberships Awarded to 177

DURING the last twelve months 177 members of the Society were less than 70 years old and had completed 35 years of corporate activity, or had completed their 25th year of corporate participation in Society activities and were 70 or more years of age. This period of service it is the Society's custom to recognize by the award of a certificate of life membership which carries with it the remission of all further payment of dues. The presentation of these certificates to attest the change in status was begun in 1938.

Many of the recipients, in acknowledging the Secretary's letter acquainting them of their new status, admit surprise that the years can so outrun their real ages, but all find occasion for enthusiastic pride in their long association. According to one, "I have always considered it a great privilege to be a member of the foremost Society in the country and have always found it to be a great help to me, with its high aims for the advancement of engineering, and the good of the country at large. With best wishes for its continued success..." Another writes, "I feel honored by this distinction and shall always strive to uphold the honor of the Society." A little ruefully, a third recipient expresses appreciation not unmixed with regret: "Gratification and pleasure at being remembered ... in such a handsome way was naturally my first reaction. Professional pride in having contributed to the profession I love through its foremost voluntary membership organization came to mind next; and then inevitably followed the realization that a certificate of the kind presented is almost like a ticket permitting the holder to travel to the far beyond ... and that ... a back seat is kept vacant for him."

Many of the Local Sections have adopted the custom of presenting these certificates with a special ceremony at a Local Section meeting. Where no such programs are planned, the certificates are mailed direct from Society Headquarters. Members who have received the distinction effective January 1, 1941, are listed in the accompanying table.

MEMBERS EXEMPT JAN. 1, 1941

Aikenhead, James Ray
Alexander, Henry James
Alexander, Robert Lee
Archer, Augustus Rowley
Backes, William James
Ballou, Henry Welcome
Barlow, DeWitt Dukes
Bartlett, Henry Emmett
Beal, George Safford
Bedford, Thomas Archibald
Berg, John
Billings, Asa White Kenney
Binckley, George Sydney
Bissell, Clinton Talcott
Blackwell, Paul Alexander
Blickle, Herman Renner
Blossom, Francis
Booz, Horace Corey
Breneman, Paul Bruce
Briggs, Harry Alson
Brooke, George Doswell
Brooks, Miles Elijah
Brown, Paul Goodwin
Buehler, Walter
Burgess, Philip
Burgoyne, John Henry
Bush, Philip Lee
Butterfield, Herbert Mitchell
Carson, John
Class, Charles Frank
Conard, William Roberts
Conrad, Lowell Edwin
Conzelman, John Edward
Corey, Ray Howard
Coulson, Benjamin LeFevre
Craig, George Washington
Cryder, Howard Michael
DeBerard, Wilford Willis
DeGraff, Harry Westbrook
Dempster, Osborne Joel
Dencer, Frederick William
Derrick, Guy Hamilton
DeYoung, Isaac
Diamant, Arthur Herbert
Dilks, Lorenzo Carlisle
Dodge, James Lynn
Dodge, Samuel Douglass
Doten, Leonard Smith
Doyle, John Stephen
Duis, Frederick Bernhardt
Dunham, William Robert, Jr.
Dunn, Gano
Elrod, Henry Exall
Falter, Philip Henry
Farnham, Robert
Firth, Elmer Wallace
Fox, John Angell
French, Mansfield Joseph
Goodman, Joseph
Gordon, Fred Force
Greensfelder, Albert Preston
Haehl, Harry Lewis
Hall, Martin Welch
Haring, Alexander
Harshbarger, Elmer Dwight
Heckle, George Rogers
Hench, Norman MacPherson
Henderson, Adelbert Andrew
Hepburn, Frederick Taylor
Herrmann, Frederick Charles
Hesse, Fred
Hewitt, George
Hoad, William Christian
Hogue, Chester James
Holt, Lester Morton
Holtzman, Stephen Ford
Hood, John Mifflin, Jr.
Hurlbut, Charles Chase
Hyde, Howard Elmer
Insley, William Henry
Jubb, Sherman Augustus
Judell, Adolph
Kabashima, Masayoshi
Kanary, Mark Henry
King, Everett Edgar
Kirkham, John Edward
Kirtland, Elmour Fitch
Kolb, Henry Jacob
Latey, Harry Nelson
Lawson, Lawrence Milton
Lee, Elsworth Mortimer
Lee, Robert Hileman
Lindau, Alfred Emanuel
Maclay, Edgar Gleim
Manley, Laurence Bradford
Meads, Charles
Melick, Neal Albert
Minniss, George Stewart
Monniche, Tollef Bache
Montzheimer, Arthur
Moore, Egbert Jessup
Morse, Charles Francis
Moyer, Albert
Mueser, William
Muller, Leslie
Murray, John Francis
Nial, William Augustine
Nimmo, James Vallence
Northrop, Albert Allen
Orcutt, William Warren
Orr, John
Palmer, Marshall Barker
Parker, Orlando Kenton
Pawling, George Franklin
Peck, Ermon Miland
Pierce, Frederic Emery
Polk, Armour Cantrell
Prentice, William Hendry, Jr.
Price, Paul Leon
Priest, Benson Bulkeley
Pullar, William Murray
Randolph, John Hampden, Jr.
Reed, Paul Lyon
Reedy, Oliver Thomas
Ridgway, Arthur Osbourne
Ripley, John Wesley
Robbins, Arthur Graham
Robbins, Dana Watkins
Robinson, George Loomis
Rockwell, William Lincoln
Rodriguez, Arturo
Ryder, Ely Morgan Talcott
Savage, Seward Merrill
Schade, Charles George
Schermerhorn, Richard, Jr.
Shackelford, William James
Shaw, Arthur Monroe
Shaw, Walter Adam
Shedd, George Garnett
Sherman, Edward Clayton
Shryock, Joseph Grundy
Skinner, Fenwick Fenton
Smith, Howard Everett
Smith, John Herman
Smith, Robert Colfax
Snyder, Charles Herman Francis
Soper, Ellis Clark
Sparhawk, George Francis
Stengel, Carl Henry
Stephenson, Frank Henry
Stilson, Jay Alvord
Stone, Willard Wilberforce
Sudriers, Victor Boureau
Sundstrom, Alfred Yngve
Swezey, Edwin Charles
Talbert, Charles Mason
Terry, Alfred Howe
Thayer, Horace Richmond
Thorn, Columbus William
Thuringer, Charles
Tucker, Edward Austin
Turner, Henry Chandlee
Vance, Alexander Milton
von Piontkowski, Edgar Stanislaus
Walker, Edward Lloyd
Waller, Percy
Walling, Victor Roy
Ward, Thomas Robert John
Wells, George Miller
Whitman, Ezra Bailey
Whitney, Alfred Rutgers
Whitson, Abraham Underhill
Whitted, Levi Romulus
Whittemore, Joseph Ogier
Wilhelm, Jerome Frederick
Winslow, Arthur Ellsworth
Yates, Joseph Johnson

Eddies from the Wake of the Freeman Scholar

Haywood G. Dewey, the Society's Freeman Traveler for 1940–1941, is confining his visits to laboratories of the United States in accordance with the terms of this year's award. He writes of various hydraulic developments as he goes along. We quote from his current reports in part:

"The Iowa Institute of Hydraulics, in cooperation with various government agencies, is concentrating on the study of fluid turbulence, the sedimentation of streams, and a correlation of these two. An attempt is being made to develop an analytical solution for the many problems met in determining suspended sediment concentration."

At the St. Anthony Falls Hydraulic Laboratory of the University of Minnesota, "much work has been done and is being continued on bed-load movement at the confluence of rivers and in river contraction works. Another problem of considerable importance and one only recently recognized is that of high-velocity flow in open channels. The results of this study will have an important practical value in relation to the design of spillways and stilling pools."

The laboratory at the University of Wisconsin is studying tank truck hydraulic systems to permit faster unloading. "To accomplish this a careful study has been made of the losses in pipes, meters, valves and fittings used for fuel oils, gasoline, cleaning fluid, and water. Problems completed include a study of weir coefficients for flow of water and oil, and a study of water-hammer in small pipes."

At the University of Illinois, "One research project of considerable interest involves a study of turbulent flow through annular tubes. Its purposes are to investigate the velocity distribution to see if it has a linear characteristic when plotted semi-logarithmically, and to observe the losses due to friction. At present the main apparatus consists of a long section of 2-in. pipe placed concentrically in a 6-in. pipe, with pitot tubes inserted into the annular space."

Particular attention is being paid to cavitation problems at the Carnegie Institute of Technology. "At present, cavitation studies are being made on baffle piers placed at the toe of a dam. Usually baffle piers are not placed in high-velocity flow because of the fear that cavitation erosion will occur. This study, therefore, will attempt to design either a baffle pier free from cavitation or one which will be protected from cavitation effects. If the project is successful, large savings can be made in the design of stilling pools by reducing their length and depth through the use of baffle piers."

Tests on venturi meter coefficients are continuing at the University of Pennsylvania. "In the study to determine the effect of installation, the venturi meter is placed at varying distances from reducers, elbows, valves, etc. It is also placed in bends which are in either horizontal or vertical planes. From the results it is possible to determine the best position of the venturi meter for producing a flat coefficient curve over most of the range of operation. One phase of the effect of installation is particularly interesting. When coefficients were plotted against the Reynolds' number, the dispersion was unsatisfactory, particularly in the lower values. It was finally discovered that the effect of ambient temperatures on the coefficients was appreciable. Accordingly tests were made with insulated meters with the result that practically no dispersion was found for lower values of the Reynolds' number."

Annual Meeting of the Engineering Foundation

At the annual meeting of the Engineering Foundation, recently held, the following officers were reelected: O. E. Buckley, president of the Bell Telephone Laboratories in New York, chairman; F. F. Colcord, vice-president of the U.S. Smelting Refining and Mining Company of New York, vice-chairman; Otis E. Hovey, M. Am. Soc. C.E., director; and John H. R. Arms, secretary.

The executive committee is headed by Dr. Buckley as chairman; other members are Mr. Colcord; Kenneth H. Condit, dean of the School of Engineering at Princeton University; A. L. J. Queneau, metallurgist of the U.S. Steel Corporation, New York; Joel D. Justin, M. Am. Soc. C.E., consulting engineer of Philadelphia, and Mr. Arms, secretary.

Reelected to the Foundation's Research Procedure Committee were the following: H. E. Wessman, M. Am. Soc. C.E., professor of structural engineering at New York University; Sam Tour, of Lucius Pitkin, Inc., New York; W. H. Fulweiler, Assoc. M. Am. Soc. C.E., consulting engineer of Philadelphia; L. W. Chubb, director of research of the Westinghouse Electric and Manufacturing Company, East Pittsburgh; E. M. T. Ryder, M. Am. Soc. C.E., way engineer, Third Avenue Railway System, New York; Dean Condit, chairman; and Dr. Buckley.

Twenty-four researches were endorsed by the Engineering Foundation Board for continued support by grants during its fiscal year 1940–1941. These include investigations in the fields of civil, mining and metallurgical, mechanical, and electrical engineering, covering various problems of soil mechanics and foundations, hydraulics, alloys of iron, and friction and creep of metals; critical-pressure steam boilers, fluid meters, cottonseed processing, cold rolling steel; paper insulation and insulating oils and cable saturants; welding; and plastic flow of concrete. Professional development of the engineer also received the recognition of the board by a grant toward the work of the Engineers' Council for Professional Development.

Forecast for January "Proceedings"

Analysis of Statically Indeterminate Structures by Successive Approximations

By O. T. Voodhigula, Jun. Am. Soc. C.E.

A useful and time-saving method that should contribute to a better understanding of the structure.

Dynamic Stress Analysis of Railway Bridges

By R. K. Bernhard, M. Am. Soc. C.E.

A simplified method of using nomographs to determine stresses due to dynamic impact.

Laboratory Investigations, Soils at Flushing Meadows Park

By Donald M. Burmister, Assoc. M. Am. Soc. C.E.

Points a way to the correlation of test results for very weak soils.

Concrete in Seawater: A Revised Viewpoint Needed

By Homer M. Hadley, Assoc. M. Am. Soc. C.E.

No evidence is found of seawater (sulfate of magnesium) attack and therefore special precautions against it are needless.

Hydraulics of Sprinkling Systems for Irrigation

By J. E. Christiansen, Assoc. M. Am. Soc. C.E.

A study to determine the characteristics of rotating sprinklers and sprinkler lines.

Experiences in Operating a Large Chemical Treatment Plant

By George J. Schroepfer, Assoc. M. Am. Soc. C.E.

Analysis of complete operating data covering a two-year period at the Minneapolis–St. Paul Sewage Plant.

Rigid Frames Without Diagonals (The Vierendeel Truss)

By Louis Baes

Analysis simplified by the fact that the points of contraflexure occur at the midpoints of vertical members.

Construction Engineering Prize to Russell G. Cone

As announced in the November issue of CIVIL ENGINEERING, the Construction Engineering Prize for 1940 is to be awarded to Russell G. Cone, M. Am. Soc. C.E., for his paper, "Field Practice with Special Reference to Golden Gate Bridge," in the July number of CIVIL ENGINEERING.

This is the second award of the Construction Engineering Prize, the first having been made last year. Following the regular procedure, presentation of the prize will take place at the Society's Annual Meeting in January. The prize was established in 1939 through the generosity of A. P. Greensfelder, M. Am. Soc. C.E., and may be given annually for the best original scientific or educational paper on construction published in CIVIL ENGINEERING. It is the only prize specifically limited to material appearing in that publication. The award is made on recommendation of the Executive Committee of the Construction Division, followed by approval of the Board of Direction.

RUSSELL G. CONE

Much of Mr. Cone's professional experience has been acquired in the field of bridge engineering. In 1922—after service overseas as sergeant with the 149th Field Artillery—he was appointed junior engineer on the construction of the Philadelphia–Camden Bridge. Later he was promoted to assistant engineer and, finally, resident engineer in charge of construction of the main bridge section. From 1927 to 1929 he was resident engineer on the construction of the Ambassador Bridge at Detroit; from 1929 to 1933 general manager of the Tacony-Palmyra Bridge at Philadelphia; and from 1933 to 1937 resident engineer on the construction of the Golden Gate Bridge at San Francisco. In the latter year he succeeded Joseph B. Strauss as engineer for the Golden Gate Bridge and Highway District and is now serving in that capacity. Recently Mr. Cone was appointed a member of the Board of Investigation of the Tacoma Narrows Bridge by the Washington State Toll Bridge Authority.

Civilian Protection Activities Outlined

Appointments to Society Committees Announced

AFTER THOROUGH STUDY and following coordinating conferences with representatives of the War Department, the Society's Committee on Civilian Protection, headed by Chairman Walter D. Binger and Vice-Chairman and Contact Member Ernest P. Goodrich, has formulated a working basis for procedure. Executive members have been appointed to direct the work in each of five categories of defense studies.

The committee has characterized the scope of its activities and distributed assignments in the following way:

Structures—JOHN I. PARCEL (St. Louis, Mo.). Design and construction of bomb shelters; investigation of skyscrapers and other types of buildings as protection against splinters and bombing; protection of major bridges and tunnels.

Transportation—CHARLES B. BREED (Boston, Mass.). (*a*) Highway Allocation: Secondary road systems to supplement military roads; study of standard methods of strengthening small highway bridges of different types; specific studies by districts. (*b*) Water Transportation: Study of means for temporary repairs to docks and waterfront bulkheads of different types; emergency methods for making waterfront structures more fire resistant. (*c*) Railways: Liaison with railways in perfecting emergency transportation methods.

Sanitation and Public Health—SAMUEL A. GREELEY (Chicago, Ill.). (*a*) Sanitation: Water supply; sewage treatment; refuse removal; passive protection against external enemy action; general plans for perfecting grid systems of sewerage and water piping; plans for home incineration in ordinary boilers. (*b*) Public Health: Cooperation with public health agencies on prevention of communicable and water-born diseases resulting from population dislocations and concentrations.

Disaster Control, Sabotage, Camouflage—ALLEN J. SAVILLE (Richmond, Va.) The protection of all the above against internal enemy action; the combination with all the others on the movement of populations and the preparation of specifications for this; information for police and other protective agencies on what to protect; general interpreter, for the civilians, of the engineers' findings.

Power—PHILIP SPORN (New York, N.Y.) Passive protection of power generating plants, transformer stations, and transmission lines against external enemy action. General plans for perfecting grid systems. Plans for emergency light and power generation by local emergency units.

Brooklyn Polytechnic Student Chapter Enjoys Hospitality of Rensselaer Group

IN connection with its three-day inspection trip to points of civil engineering interest in the Hudson River valley, the Student Chapter at Brooklyn Polytechnic Institute was entertained at an informal get-together with members of the Chapter at Rensselaer Polytechnic Institute. The meeting was arranged by the R.P.I. men when it was learned the Brooklyn group was traveling that way.

A brief smoker in the Rensselaer club rooms was followed by an inspection of the soil mechanics, sanitary, and photogrammetric laboratories. Discussions were continued until late in the evening. Other interesting features of the trip included visits to the Bronx-Whitestone Bridge, the Albany filtration plant, stream gaging stations of the U.S. Geological Survey, and the federal lock and dam at Troy.

Student Chapters everywhere are urged to explore the possibilities of joint meetings during trips of this kind. Host groups will nearly always be found eager to cooperate if they can be notified far enough in advance.

Appointments of Society Representatives

ARTHUR E. GORMAN, M. Am. Soc. C.E., has been appointed to represent the Society on the Advisory Committee in charge of the revision of the present Treasury Department Drinking Water Standards for drinking and culinary water supplied by interstate carriers.

JOHN P. HOGAN, President Am. Soc. C.E.; FREDERICK H. FOWLER, President-elect Am. Soc. C.E.; JOHN C. HOYT and CARLTON S. PROCTOR, Members Am. Soc. C.E.; and GEORGE T. SEABURY, Secretary Am. Soc. C.E., have been appointed to represent the Society on the Construction League of the United States for 1941.

ARTHUR N. TALBOT, Past-President Am. Soc. C.E., represented the Society at the dedication of the State Natural Resources Building at the University of Illinois on November 15.

Society Notes

SOME of our authors who contend that editors exist for the sole purpose of making doormats of their manuscripts will be gratified to learn that this was almost exactly the fate of one paper. It was found, about eight weeks after it had been sent out, under a reviewer's doormat where it had been carefully placed by the postman on a "weathery" day.

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THE *Georgia Section News* has instituted a "Bellup" poll in keeping with trends in national politics. As a consequence, its November 12 issue predicted the election of Hal H. Hale as president, William A. Spell as vice-president, and George A. Belden as state vice-president. The incumbent candidate for secretary-treasurer, F. M. Bell, offered to concede the election of any competitor for that office who could be persuaded to run.

Lists of Professional Men Available

For the past several months, the National Committee on Construction Preparedness, working through the Local Sections of the Society, has been engaged in the preparation of a list in each community of the engineers, draftsmen, designers, and others who are available for employment on the construction preparedness program. There follows a record of the names and addresses of the custodians of the several lists. Government agencies, engineering firms, and contractors who are seeking the services of professional personnel to augment their staffs, should consult the custodian named nearest to their project. Engineers who are available for such service should make their qualifications known to the custodian named nearest to their residence.

ALABAMA—*Birmingham*, L. L. Rhudy, Mgr., Alabama State Employment Service, 200 Phoenix Bldg.

ARIZONA—*Phoenix*, Vic H. Housholder, Pres., Arizona Section, Am. Soc. C.E., 336 E. Palm Lane.

ARKANSAS—*Little Rock*, Harry W. Wright, State Highway Dept.

CALIFORNIA—*Los Angeles*, Don H. McCreery, Chm., Employment Committee, Los Angeles Section, Am. Soc. C.E., 1708 W. 8th St. *Sacramento*, Theodore Neuman, Secy., Sacramento Section, Am. Soc C.E., 1964 Bidwell Way. *San Diego*, C. W. Capwell, Secy., San Diego Section, Am. Soc. C.E., 255 Sea Vale St., Chula Vista. *San Francisco*, Newton D. Cook, Mgr., Engineering Societies Personnel Service, 57 Post St.

COLORADO—*Denver*, Charles M. Lightburn, Room 525 Cooper Bldg.

CONNECTICUT—*Hartford*, W. A. D. Wurts, Pres., Connecticut Section, Am. Soc. C.E., 550 Main St.

DISTRICT OF COLUMBIA—*Washington*, Nathan C. Grover, 2223 North Interior Bldg.

FLORIDA—*Jacksonville*, Chas. F. Lovan, Secy., Florida Section, Am. Soc. C.E., 111 W. Ashley St. *Miami*, Leroy S. Edwards, Secy., Miami Section, Am. Soc. C.E., 6812 Biscayne Blvd. *Tallahassee*, Herbert D. Mendenhall, Secy., Fla. Eng. Soc., 814 W. Jefferson St.

GEORGIA—*Atlanta*, Hal H. Hale, Pres., Georgia Section, Am. Soc. C.E., 917 Hurt Bldg.

ILLINOIS—*Chicago*, Craig P. Hazelet, Secy., Illinois Section, Am. Soc. C.E., 53 W. Jackson Blvd.; Thomas Wilson, Mgr., Eng. Soc. Personnel Service, 211 W. Wacker Drive. *Urbana*, Harold E. Babbitt, Secy., Ill. Soc. of Engrs., 204 Eng. Hall; Henry P. Evans, Secy., Central Ill. Section, Am. Soc. C.E., 417 Eng. Hall.

INDIANA—*Indianapolis*, C. S. Hadden, Secy., Indiana Engineering Council, 511 Occidental Bldg.

IOWA—*Des Moines*, L. L. Flint, Managing Director, Professional Div., Iowa Eng. Soc., 517 Old Colony Bldg.

KANSAS—*Topeka*, Geo. W. Lamb, Secy., Kansas Section, Am. Soc. C.E., 1297 MacVicar.

LOUISIANA—*New Orleans*, V. J. Bedell, Secy., Louisiana Section, Am. Soc. C.E., 5th Floor, Municipal Bldg.

MARYLAND—*Baltimore*, Gustav Requardt, Engineers' Club, 6 West Fayette St.

MASSACHUSETTS—*Boston*, Geo. Gilmore, Exec. Dir., Emergency Planning and Research Bureau, Inc., 4 Park St.

MICHIGAN—*Detroit*, Ben W. Beyer, 1347 Book Bldg.; Louis E. Williams, Mgr. Eng. Soc. Personnel Service, 272 Hotel Statler.

MINNESOTA—*St. Paul*, Miss Katherine A. Feucht, Secy., Minn. Federation of Architectural and Engineering Societies, 819 Guardian Bldg.

MISSISSIPPI—*Vicksburg*, Norman R. Moore, U.S. Engr. Office.

MISSOURI—*Rolla*, H. C. Beckman, Pres., Mid-Missouri Section, Am. Soc. C.E., 208 E. 12th St. *St. Louis*, C. W. S. Sammelman, Secy., Engineers' Club, 4359 Lindell St.

NEBRASKA—*Lincoln*, J. P. Colbert, Secy., Nebraska Eng. Society, Univ. of Nebraska.

NEW YORK—*Buffalo*, Nelson Stone, Pres., Buffalo Section, Am. Soc. C.E., 63 Ruskin Rd., Eggertsville. *Ithaca*, John E. Perry, Secy., Ithaca Section, Am. Soc. C.E., 952 East State St. *New York*, Alfred H. Meyer, Exec. Secy., and Walter V. Brown, Mgr., Engineering Societies Personnel Service, 29 West 39th St. *Rochester*, Albert R. Reilly, 13 S. Fitzhugh St. *Troy*, G. Reed Shaw, Secy., Mohawk-Hudson Section, Am. Soc. C.E., R.F.D. 4.

NORTH CAROLINA—*Raleigh*, Prof. C. L. Mann, State College Station.

OHIO—*Cleveland*, J. H. Anderson, Pres., Cleveland Section, Am. Soc. C.E., 18127 W. Clifton Rd., Lakewood. *Columbus*, Claude Allen Porter Turner, 22 East Gay St., Room 888. *Dayton*, J. J. Chamberlain, Jr., Pres., Dayton Section, Am. Soc. C.E., 102 W. Norman Ave.

OKLAHOMA—*Oklahoma City*, D. L. Wilson, Pres., Oklahoma Section, Am. Soc. C.E., 2700 N.W. 13th St.

OREGON—*Portland*, Norbert Leupold, Secy., Oregon Section, Am. Soc. C.E., 500 Pittock Block.

PENNSYLVANIA—*Bethlehem*, M. O. Fuller, Secy., Lehigh Valley Section, Am. Soc. C.E., Room 201 Packer Hall, Lehigh Univ. *Philadelphia*, Technical Service Committee, Engineers' Club, 1317 Spruce St. *Pittsburgh*, K. F. Treschow, Secy., Engrs. Soc. of Western Pa., Wm. Penn Hotel.

RHODE ISLAND—*Providence*, J. D. Eldert, 271 Washington St. (Machine Parts Corp.)

SOUTH CAROLINA—*Columbia*, Albert E. Johnson, Secy., S. C. Section, Am. Soc. C.E., 119 U.S. Court House.

TENNESSEE—*Knoxville*, E. B. Rhegness, Dist. Mgr., Tenn. State Employment Service. *Memphis*, E. F. Bespalow, Box 2057, DeSoto Station. *Nashville*, L. R. Currey, Pres., Nashville Section, Am. Soc. C.E., 926 Third National Bank Bldg. *Chattanooga*, Henry S. Bloker, Mgr., Chattanooga Office, Tenn. Employment Service, 123 East Ninth St.

TEXAS—*Houston*, R. M. Hutchison, Pres., Houston Engineers Club, 2615 Fannin St.

VIRGINIA—*Richmond*, P. A. Rice, Secy., Virginia Section, Am. Soc. C.E., 402 Broad St. Station.

Undisturbed Soil Sampling Is Subject of Committee Report

THE Committee on Sampling and Testing of the Soil Mechanics and Foundations Division of the Society has delivered to The Engineering Foundation the remaining copies of the report by its Research Engineer, M. Juul Hvorslev, Assoc. M. Am. Soc. C.E., on "The Present Status of the Art of Obtaining Undisturbed Samples of Soils." Although designated as a preliminary draft, it is probably the only report that the committee will issue on this general subject.

Comprising 88 pages with 83 figures, the report gives comprehensive data on current methods and equipment for the sampling of soils. There is included a brief review of the general methods of soil exploration in use and an analytical discussion of the character and influence of the various types of disturbance to soil samples, and of the problems encountered in securing such samples with a minimum of disturbance.

The Engineering Foundation is the financial sponsor of this project for the development of better sampling methods and equipment. After the completion of the investigations now under way, a final report, containing recommended procedures and equipment for the various conditions encountered in actual foundation investigations, will be prepared. Copies of the current report may be obtained from The Engineering Foundation, 29 West 39th Street, New York City, at the price of $3.00 each.

News of Local Sections

Scheduled Meetings

CLEVELAND SECTION—Annual meeting on January 6.

DAYTON SECTION—Luncheon meeting at the Engineers Club on January 20, at 12:15 p.m.

DISTRICT OF COLUMBIA SECTION—Annual dinner meeting at the Washington Hotel, Washington, on January 24.

ILLINOIS SECTION—Dinner meetings of the Junior Section at the Central Y.M.C.A. (19 South La Salle Street) on January 13 and January 27, at 6 p.m.

INDIANA SECTION—Dinner meeting at Hurty Hall, Indiana State Board of Health Building, on January 10, at 6:15 p.m.

IOWA SECTION—Joint smoker with the Iowa State College Student Chapter at the Memorial Union, Iowa State College, on January 15, at 7:30 p.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on January 8, at 6:30 p.m.

LOUISIANA SECTION—Technical meeting at the St. Charles Hotel in New Orleans on January 10 at 10 a.m. (held in conjunction with annual convention of the Louisiana Engineering Society). Annual meeting at 508 Millamdon Street on January 17.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building in New York City on January 8, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Alcazar Hotel on January 2, at 7 p.m. (visiting members cordially invited).

MICHIGAN SECTION—Dinner meeting at the Michigan Union, Ann Arbor, on January 24, at 6:30 p.m.

MOHAWK-HUDSON SECTION—Evening meeting followed by buffet supper at the Rensselaer Union Club House, Rensselaer Poytechnic Institute, Troy, on January 7, at 8 p.m.

NORTHEASTERN SECTION—Dinner meeting at the Engineers Club on January 20, at 6 p.m.

OREGON SECTION—Annual meeting at the Congress Hotel on January 10, at 7 p.m.

PHILADELPHIA SECTION—Dinner meeting at the Engineers Club on January 14, at 6 p.m.

PITTSBURGH SECTION—Lecture at the William Penn Hotel on January 16, at 8:15 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:15 p.m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on January 27, at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting of the Junior Forum at the Engineers Club on January 21, at 5:45 p.m.

SEATTLE SECTION—Annual business meeting at the Engineers Club on January 27, at 6 p.m.

SPOKANE SECTION—Luncheon meeting at the Davenport Hotel on January 10, at 12 m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on January 6, at 12:10 p.m.

Recent Activities

CENTRAL OHIO SECTION—*Columbus, November 14:* During the business session it was announced that the following officers have been elected for the coming year: C. V. Youngquist, president; C. W. Allen, first vice-president; Fred E. Swineford, second vice-president; and Eric Tahlman Krumm, secretary-treasurer. The technical program consisted of a talk on "Locating and Monumenting Land Lines," which was given by E. E. Coddington, emeritus professor of civil engineering at Ohio State University. Professor Coddington also discussed a proposal providing appropriations for the formation of a "Bureau of Surveys and Maps," to be brought before the state legislature.

CLEVELAND SECTION—*November 12 and December 2:* A record-breaking attendance turned out for the first of these meetings to hear Samuel W. Marshall, chief engineer of the Pennsylvania Turnpike Commission, discuss the turnpike project. Mr. Marshall showed slides illustrating the various stages of construction, and an enthusiastic discussion followed his talk. The speaker at the second meeting was E. S. Tisdale, sanitary engineer for the U.S. Public Health Service, who presented an illustrated lecture on "The Ohio River Pollution Survey."

COLORADO SECTION—*Denver, November 18:* A symposium on engineering education was the feature of the occasion. Those participating were John H. A. Brahtz, senior engineer for the U.S. Bureau of Reclamation, whose subject was "Preparation for Research"; Arthur O. Ridgway, chief engineer for the Denver and Rio Grande Western Railroad Company, who spoke on "Preparation for General Engineering Practice"; M. C. Hinderlider, state engineer and secretary-treasurer of the State Board of Engineer Examiners, who discussed "Preparation for an Engineering License"; and C. L. Eckel, head of the civil engineering department at the University of Colorado, whose subject was "The S.P.E.E. Recommendations." *Junior Association—May 27 and October 28:* Talks on the Denver sewerage system and disposal plant were given by Charles A. Davis, sanitary engineer for the city of Denver, and Dana E. Kepner, manufacturers' representative for Water Works, Sewerage and Power Equipment. At the October meeting August L. Ahlf, a member of the group, read an illustrated paper on the Great Pyramids of Egypt.

DAYTON SECTION—*November 18:* The feature of the occasion was an illustrated talk on "Soil Conservation from an Engineer's Standpoint." This was given by Ralph Morrish, agronomist for the U.S. Soil Conservation Service.

GEORGIA SECTION—*Atlanta, November 18:* Members of the local branches of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers were guests of the Section at this luncheon meeting, which was voted the most successful of the year. A paper on "The Development of the Steel Rail" was presented by J. B. Akers, assistant chief engineer of the Southern Railway.

HAWAII SECTION—*Honolulu, September 10 and November 13:* The speaker on the first of these occasions was A. A. Lindau, chairman of the Society's Committee on Specifications for Concrete and Reinforced Concrete, who discussed in some detail the work of the committee and presented a talk entitled "Changes and Developments in Concrete Methods." Mr. Lindau is at present engaged as consultant by the 14th Naval District at Pearl Harbor, and a general discussion of the concrete designs selected by the navy followed his talk. At the November meeting the speaker was Lt. Comm. Charles T. Dickeman, who is in charge of the construction of drydocks for the 14th Naval District at Pearl Harbor. Commander Dickeman's talk covered the details of designing the drydocks, the placing of the concrete, foundation problems, and the pioneer work performed in placing the tremi concrete.

ILLINOIS SECTION—*Chicago, October 22 and November 30:* The first of these meetings was a joint session with the Chicago Engineers' Club. A technicolor film, entitled "Behind the Water Tap," was shown through the courtesy of the Industrial Chemical Company. The November dinner meeting honored the Society's Committee on Professional Objectives and the ten new life members from the Section, who received their certificates. Presentation of the certificates was made by Field Secretary Jessup. The technical program consisted of talks by A. M. Rawn, chief engineer of the Los Angeles County Sanitation Districts; Ivan C. Crawford, dean of the college of engineering at the University of Michigan; and Frederic Bass, professor of municipal and sanitary engineering at the University of Minnesota.

INDIANA SECTION—*Indianapolis, November 1:* The feature of the occasion was an illustrated lecture on "The New Bio-Chemical Sewage Treatment Plant at Anderson, Ind.," given by B. A. Poole, chief engineer of the Bureau of Sanitary Engineering of the Indiana State Board of Health. *Fort Wayne, November 15 and 16:* The Section was one of the groups participating in the Indiana Engineering Council, whose 61st annual meeting took place on these dates. A number of the members of the Section attended the meeting, and the Section was in charge of one of the technical sessions. M. R. Keefe, chief engineer of the Indiana State Highway Commission, presented a paper on the subject of "Feasibility of Limited Access Superhighways in Indiana." Another member of the Section—W. A. Knapp—was elected president of the Indiana Engineering Council for 1941.

Iowa Section—*Des Moines, November 21:* In the afternoon there was a business meeting, at which the following officers were elected for the coming year: Mark B. Morris, president; M. C. Miller, vice-president; and L. O. Stewart, secretary-treasurer. Several reports were presented, and Maurice Albertson and Darrell Schumacher, presidents of the Student Chapters at Iowa State College and the State University of Iowa, outlined the work of their respective Chapters. In the evening there was a symposium on the subject, "The Education of the Civil Engineer." In addition to the talks by the scheduled speakers—A. H. Fuller, Howard R. Green, and Raymond R. Zack—there was considerable informal discussion.

Ithaca Section—*November 28:* A dinner on the campus of Cornell University preceded the meeting. The speaker at the technical meeting was Maj. J. C. Marshall, district engineer for the U.S. Corps of Engineers at Binghamton, N.Y., who discussed the changes in and reorganization of the Corps.

Kansas Section—*Topeka, November 15:* A talk on South America was given by Lt. Col. J. H. Ruckman. This was followed by a sound motion picture, furnished by Pan-American Airways, which showed a flight from Miami, Fla., to Rio de Janeiro.

Kansas City Section—*November 14:* The feature of the technical program was a symposium on "The Civil Engineer in National Defense," the principal speakers being Col. J. F. Brown, Commanding Officer of the 110th Engineers, and Maj. Robert W. Reed. Colonel Brown discussed the activities of the civil engineer in the War and Navy departments, while Major Reed talked on engineering phases of military operations in Europe. A spirited discussion concluded the meeting.

Los Angeles Section—*Pasadena, November 13:* There was no technical program, as this was the annual Ladies' Night. Dinner was followed by six acts of vaudeville, and dancing and bridge concluded the evening. The Section announces that the following officers have been elected to serve during 1941: E. R. Bowen, president; H. E. Hedger, first vice-president; Don H. McCreery, second vice-president; Trent R. Dames, secretary; and Fred D. Bowlus, treasurer.

Louisiana Section—*New Orleans, November 25:* A number of Student Chapter members from Louisiana State University and Tulane University attended this meeting. Glen Nelson Cox, professor of mechanics and hydraulics at Louisiana State University, addressed the gathering on "Present-Day Hydraulics."

Maryland Section—*Baltimore, October 22 and November 26:* The program at the first of these meetings consisted of a talk on "National Defense Highways in Maryland," given by Maj. Ezra B. Whitman, chairman of the Maryland State Roads Commission. The speaker at the November meeting was Peyton Magruder, who gave an illustrated lecture on the subject, "Our Expanding Aeroplane Production." *Junior Association:* The Junior Association reports that it has held several meetings in the past months and that the list of speakers addressing these gatherings has included Dr. Sheppard, of the psychology department at Johns Hopkins University; John M. Coan, Jr., John T. Starr, L. C. MacMurray, G. W. Schucker, A. F. Sack, and Frank B. Hall, all members of the Association.

Metropolitan Section—*November 20:* A symposium on "Civil Defense Measures in War Time" was the feature of the occasion. The scheduled speakers were Walter D. Binger, chairman of the Society's Committee on Civilian Protection and Commissioner of Borough Works of Manhattan; Col. Lucian B. Moody, Ordnance Officer for the First Army; and William A. Rose, professor of structural and architectural engineering at New York University. The papers were illustrated with lantern slides, and considerable general discussion followed.

Mid-Missouri Section—*Jefferson City, September 24:* The feature of the occasion was an address on "The Desirability of a Law for Licensing Engineers," given by Clifford B. Kimberly, civil engineer and attorney at law. *Columbia, November 29:* The officers and senior class members of the Student Chapters at the University of Missouri and the Missouri School of Mines were guests of the Section for dinner and a meeting. R. A. Smith, member of the University of Missouri Chapter, gave a résumé of the November issue of Civil Engineering. He was followed by Morris DeWitt, of the Porter-DeWitt Construction Company, who gave an illustrated talk on "The Construction of the Wappapello Dam."

Mohawk-Hudson Section—*Schenectady, N.Y., November 7:* Joint meeting with the Engineering Societies of Schenectady. During the business session the following officers were unanimously elected for the coming year: Edward H. Sargent, president; H. Oakley Sharp, vice-president; G. Reed Shaw, secretary; and Clyde P. Parkinson, treasurer. A talk on military highways—presented by Arthur W. Brandt, Superintendent of Public Works for the State of New York—comprised the technical program.

Nashville Section—*December 3:* New officers for the coming year were elected as follows: W. T. St. Clair, president; W. L. Picton, vice-president; and F. P. Gaines, secretary-treasurer. During the business session a motion was passed appropriating funds for prizes for Student Chapter papers. Fred J. Lewis, dean of engineering at Vanderbilt University, was the speaker of the evening and discussed engineering education in its present relation to the national defense program.

Nebraska Section—*Omaha, November 19:* The Nebraska State Planning Board's report on education and educational institutions in the state was discussed by W. H. Mengel, engineer for the Planning Board.

Northeastern Section—*Cambridge, October 16:* This meeting—a joint session with the Boston Society of Civil Engineers—was designated Student Night, and 160 representatives were present from Student Chapters at a number of New England colleges and universities. Charles R. Gow, president of the Warren Brothers Corporation, addressed the gathering on the subject," Engineering Personality as an Aid to Professional Success." *Boston November 15:* Following a dinner and business meeting the gathering was addressed by Clarence M. Blair, Society Director from the district. *Junior Association, November 12:* The Section elected the following officers for the coming year: Herman J. Shea, president; Malcolm S. Stevens, vice-president; and Paul C. Grueter, secretary-treasurer. The technical program consisted of a paper by John W. Greenleaf, Jr., on the subject, "Construction of Waste Treatment Plant for Standard Brands, Inc., at Pekin, Ill."

Northwestern Section—*Minneapolis, December 2:* On this occasion the Section entertained the ladies. Music was furnished by the Zelner Quartette, and Harold W. Lathrop, director of Minnesota state parks, showed motion pictures of the recreation facilities in the parks. During the annual business meeting, which preceded the social program, the following officers were elected for 1941: William J. Titus, president; Louis Yager, first vice-president; E. V. Willard, second vice-president; and Frank S. Altman, secretary-treasurer.

Oklahoma Section—*Oklahoma City, November 22:* This meeting was termed one of the best of the year. Following dinner there was a symposium on engineering education, in which the following participated: John F. Brookes, director of civil engineering at the University of Oklahoma; Guy B. Treat, chief engineer of the Oklahoma Railway Company; and Verne V. Long, president of V. V. Long and Company, of Oklahoma City. In addition to these scheduled speakers, there was considerable informal discussion. During the business session the following officers were elected for 1941: C. H. Guernsey, president; D. A. Leach, first vice-president; C. W. McFerron, second vice-president; and C. E. Bardsley, secretary-treasurer.

Philadelphia Section—*November 12:* A number of members and guests assembled to hear Maj. F. H. Kohloss, Executive Officer, Planning Branch, Office of the Assistant Secretary of War, explain the role of engineers in industrial mobilization. Major Kohloss suggested that the Section could help by bringing together all engineering groups in the area and initiating studies of various phases of the defense program. Other talks were given by Sanford Sawin, Director of the Society, and E. L. Shoemaker, secretary-treasurer of the Section, who discussed Society and Section affairs, respectively.

Pittsburgh Section—*November 4:* Joint meeting with the civil section of the Engineers Society of Western Pennsylvania. A talking motion picture, tracing the essential steps in the production of steel for wire rope, was presented by the Bethlehem Steel Company. *November 12 and 13:* On these two days the Section and the civil section of the Engineers Society of Western Pennsylvania held a water conference. The list of Society members who presented papers at the technical sessions includes John T. Campbell, of the Chester Engineers, Pittsburgh, and J. P. Schwada, city engi-

neer of Milwaukee, Wis. There was a smoker and social get-together on the evening of the 12th.

SACRAMENTO SECTION—*November 12, 19, and 26:* The speakers at these three luncheon meetings were H. M. Engle, engineer for the Board of Fire Underwriters of the Pacific; Stewart Mitchell, senior bridge engineer for the California State Division of Highways; and C. J. Kraebel, principal silviculturist for the U.S. Department of Agriculture. *Junior Forum:* The speaker at the monthly meeting of the Forum was Lt. Col. M. C. Bigelow, who discussed "The National Guard and Its Part in National Defense."

SAN DIEGO SECTION—*October 24:* J. Brennen, harbormaster for the port of San Diego, addressed the dinner meeting on the development of the harbor and projected national defense plans. Following his talk, the group moved to the site of a dredging operation of the San Diego Bridge Company. The operation of the dredge was explained by Fred R. Muhs, Jr., superintendent of the dredging operations.

SEATTLE SECTION—*October 28 and November 25:* The speaker at the first of these two dinner meetings was Howard H. Martin, professor of geography at the University of Washington, who discussed the subject, "Danger Zones in the Pacific." The program at the November meeting consisted of the showing of several reels of motion pictures on earth-moving equipment. These were presented by Herb Fay, of the Western Tractor Company.

SYRACUSE SECTION—*November 27:* Joint meeting with the Onondaga Chapter of the New York State Society of Professional Engineers and the Syracuse University Student Chapter. A program on engineering education was the feature of the occasion, the speakers being Louis Mitchell, dean of Syracuse University, and Alfred E. Roche, former president of the New York State Society of Professional Engineers.

TACOMA SECTION—*Olympia, Wash., November 12:* Bailey Tremper, materials engineer of the Washington State Highway Department, spoke briefly of the work being done in the Department's new testing laboratory. The meeting was then recessed to resume in the testing laboratory, where Mr. Tremper's full staff of assistants was on hand to explain various tests and perform actual demonstrations. The officers for 1941 are Fred C. Dunham, president; Lothrop Crosby, vice-president; and Clyde W. Kimbrough, secretary-treasurer.

TENNESSEE VALLEY SECTION—*Asheville, N.C., November 8 and 9:* Members of the Section opened their two-day fall meeting with a symposium on flood control problems, with special reference to the August floods in North Carolina and the Tennessee Valley. The list of speakers included W. C. Ackermann, J. E. Goddard, and Myron O. Jensen, all members of the staff of the TVA; E. D. Burchard, district engineer for the U.S. Geological Survey at Asheville; Fred V. Doutt, chief chemist of the Champion Paper and Fibre Company; and J. Heykoop, building engineer for the American Enka Company. During the annual meeting held that afternoon Erwin Harsch was elected president for the coming year, and Joseph Dave, F. W. Truss, W. F. Moehlman, and J. M. Wolfe were elected vice-presidents. At the banquet in the evening Brig. Gen. Harley B. Ferguson, U.S .Army (retired), spoke on "The United States and the War." Certificates of life membership in the Society were presented to Levi R. Whitted, Ellis C. Soper, and Frank H. Stephenson. Dancing and games concluded the evening. Saturday morning was given over to an inspection trip through the plant of the Champion Fibre Company at Canton, N.C., and the afternoon to a motor trip and golf. Special entertainment for the ladies included visits to the plant of the Biltmore Industries, the Biltmore estate, and Vanderbilt mansion.

TOLEDO SECTION—*November 9:* Members of the Section and their guests enjoyed an inspection trip to the intake crib of the Toledo Lake Erie Water Project. James Lynch, division engineer for the city on the construction of the project, explained the various features of the project and brought out the fact that the crib is one of the few in the country of the isolated type.

TRI-CITY SECTION—*November 29:* During the annual business meeting that followed dinner these officers were elected for the coming year: H. P. Warren, president; C. M. Stanley, vice-president; and M. H. Jones, secretary-treasurer. Then L. L. Flint, managing director of the Iowa Engineering Society, gave a talk on the subject, "The Engineer Today." Mr. Flint reviewed the history of the society and discussed ways in which it has benefited the engineer in Iowa.

Student Chapter Notes

BROWN UNIVERSITY—*October 23, November 13 and 21, and December 4:* On October 23 the Chapter sponsored a film concerning fire fighting at a meeting of the Brown Engineering Society. At the first of the November meetings Andrew Clark, a member of the Chapter, presented a paper entitled "The Layman's Conception of the Theory of Relativity." On the 21st the Chapter sponsored a steak supper at the Brown University Outing Reservation. The supper was a great success from the point of view of fostering a closer relationship between the engineering faculty and the students. The December meeting was devoted to a discussion of recent proposals to have a new membership grade in the Society—that of "Student Member." The Chapter rejected the suggestion.

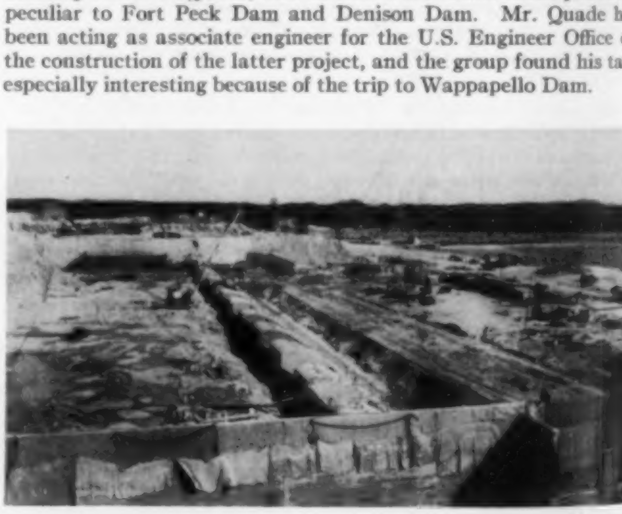
COLLEGE OF THE CITY OF NEW YORK—*December 5:* A large attendance turned out to see a motion picture of the dynamiting into place of the Chute à Caron Dam.

NEWARK COLLEGE OF ENGINEERING—*November 4 and December 2:* At the first of these sessions A. F. Eschenfelder, borough engineer of Glen Ridge, N.J., discussed the various duties of a town engineer in a suburban community. The speaker at the second meeting was Morris Goodkind, bridge engineer for the New Jersey State Highway Department, who gave an illustrated lecture on construction features of the Edison Memorial Bridge.

RENSSELAER POLYTECHNIC INSTITUTE: The Student Chapter reports that Clarence Dunham, assistant professor of civil engineering at Yale University, addressed the October meeting on the construction of the Lincoln Tunnel. On November 14 the group heard Alfred Fleming, director of conservation of the National Board of Fire Underwriters, who discussed "The Relation of Proper Building Construction to Fire Waste"; and the speaker on December 12 was Nathan I. Kass, sanitary engineer for the New York City Department of Public Works.

RUTGERS UNIVERSITY—*November 13 and 19:* A lecture on the Lake Washington Pontoon Bridge was the feature of the first of these meetings. This was given by Robert MacMinn, one of the board of consultants on the construction of the project. The speaker at the second of these sessions was Samuel F. Newkirk, Jr., engineer and superintendent of the Elizabeth (N.J.) Board of Water Commissioners, who discussed some of his experiences in his work.

WASHINGTON UNIVERSITY—*October 19 and November 12:* On the first of these dates the Chapter, through the courtesy of the U.S. Engineer Office at Memphis, Tenn., and the Porter-DeWitt Construction Company, inspected Wappapello Dam, now in process of construction on the St. Francis River south of St. Louis. Special instruction in soil mechanics and the placement of soil for earth dams was given the student group. The speaker at the November meeting was C. O. Quade, who discussed the construction problems peculiar to Fort Peck Dam and Denison Dam. Mr. Quade has been acting as associate engineer for the U.S. Engineer Office on the construction of the latter project, and the group found his talk especially interesting because of the trip to Wappapello Dam.



CONSTRUCTION OF CONCRETE WEIR AT WAPPAPELLO DAM
Project Was Visited by Washington University Chapter in October

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for February

In an article dealing with trends in power plant spacing and layout, H. G. Gerdes brings up to date and presents new aspects of a subject he originally discussed in Civil Engineering for January 1939. The influence of the structural functions of various plant elements in defining economic limits is outlined with full regard to practical factors such as the methods of forming the scroll case, use of contraction joints, or the lengths of electric cables.

Founding buttresses on unstable shale was one of the novel problems faced in the construction of the Possum Kingdom Dam. C. P. Williams has explained the procedure used in sealing the shale, and has gone further in describing design details, forms, and construction methods used throughout the dam. The dam is one of 13 proposed for the development of the Brazos River valley in Texas.

A double-swing highway bridge across the inland waterway from Norfolk, Va., to Beaufort, N. C., is described by J. K. Knoerle. Several alternative types were considered, and the arguments upon which selection was based will be found applicable to many other projects. Unusual difficulties in the bridge mechanisms, with details of the gearing connections and greasing system, are presented.

An article by C. A. Holden on "sight line profiles" will be warmly welcomed by all who have endured the neck pains developed in poorly planned theaters or stadiums. Starting with an acceptable eye clearance that will permit easy vision by one spectator over the head of another, he develops design formulas for the positions of successive rows of seats. The subject is believed to have been rarely treated in print, and the material should prove very useful to structural designers.

Other subjects that are planned for the February number include the strange strength of "bundle bars," some developments in supercritical flow, and a discussion of industrial problems presented by modern aircraft designs.

New York Schools Form Technical Institute for Defense Training

In conjunction with the nation-wide program of collegiate-grade defense training sponsored by the U.S. Office of Education, the eight engineering schools in the metropolitan area, which are Columbia University, New York University, Cooper Union, the College of the City of New York, the Polytechnic Institute of Brooklyn, Pratt Institute, Manhattan College, and Webb Institute, have organized the Technical Institute of New York. Its board of direction is made up of the deans of engineering of each of the schools represented, with Dean Newman of the College of the City of New York as chairman.

The curriculum will include essential technical courses of the first two years of engineering college work. After this training has been completed, the graduate will be eligible to enter directly into the employ of some of the war industries, especially the airplane industry, in which the demand in this region is acute. A few very capable men may go on for advanced instruction which will comprise the third and fourth years of engineering college, and which will be given in the individual institutions.

By omitting all the humanities and cutting out all non-essentials, it is expected that the first two years of college technical work can be covered in the period from February 3 to September 13. Classes will have from 20 to 25 men in each section, and plans anticipate the training of from 125 to 500 individuals, with 250 as the desired number. Admission requirements will be high-school graduation. It has been clear that industry desires maturity as well as education, and men who have been out of high school from one to ten years are to be preferred. Applicants will be approved by personnel men from the industries as well as an educational director who will pass on their scholastic requirements.

The scheduling of classes between one and ten p.m. will permit day-school instructors to devote their evenings, and night-school instructors to devote their afternoons, to the Institute Classes. It is estimated that the cost of instruction for about 250 students will be $136,611.

Hippodrome in Istanbul, Turkey, at the Mosque of Achmet I

The Page of Special Interest in this issue, showing the Blue Mosque in Istanbul, Turkey, is reproduced as further evidence of a wealth of material which has been accumulated by Dr. J. Charles Rathbun, M. Am. Soc. C.E., of City College, New York, in his world travels. This picture and the ones used in his article in this issue on "Primitive Houses of the Far East," were taken by Dr. Rathbun himself.

He states that the 60-ft Obelisk of Theodosius I, in the foreground of the picture, was brought from Egypt and erected in the hippodrome about 390 A.D. The Mosque of Achmet I was built in 1609–1614 as a rival to St. Sophia, built in 538 A.D. Its auditorium, over 200 ft square, is surmounted by a dome supported by four pillars. This mosque, the first outside of Mecca to have six minarets, and St. Sophia dominate the sky-line of Istanbul.

As an explanation to the hieroglyphics which appear on the obelisk, Dr. Rathbun offers the following:

"The most important face is that on the northwest, the one shown in the picture. At the summit of each face a small framed scene represents Thothmes kneeling and making an offering to Amon-Ra. On each face, with little variety, is the name of the double royalty, such as 'chosen of Ra, beloved of Ra, King of Upper and Lower Egypt,' etc. The descriptive part of the four columns of text states that 'this powerful prince has conquered the entire world, has extended his frontiers to the extremities of Naharin (Euphrates) and brought victory at the head of his troops; he is the foster child of Tourn (the setting sun) rocked on the edge of the Sea of the Gods, the lord of panegyrics; his royalty is as stable as that of Ra in the heavens, and he has raised this monument in honor of his father Amon the master of the thrones of Upper and Lower Egypt.'"

Dr. Rathbun has built up a large picture file of structures of primitive peoples. With the help of Mrs. Rathbun he has accumulated an interesting and valuable collection of souvenirs and relics of their world travels.

The Last P. I.

We subtly refrain
From remarking the pain
Or the look of disdain
In his eye.

But the bend in the string
And the leg in a sling
Are the sort of a thing
We decry.

—Contributed

Prof. N. G. Neare's Column

Conducted by

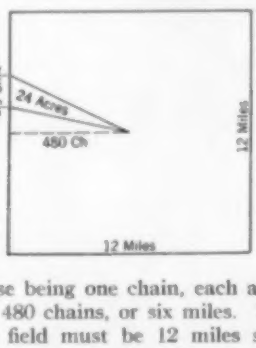
R. ROBINSON ROWE, M. AM. SOC. C.E.

THE CAUSE of Professor Neare's absence from the December meeting of the Engineers' Club was the source of considerable speculation among his associates until it was pointed out by a visiting physicist that what had happened was merely an incongruity of time and space coordinates—in fact, Professor Neare was present at the appointed time, but the space in CIVIL ENGINEERING was not.

Having nevertheless skipped a month, Professor Neare thought it desirable to recall the previous problem. "You will remember," he said, "that there was a square field enclosed by a tight board fence of 11-ft boards laid horizontally 4 boards high. Knowing that the number of boards in the fence equals the number of acres in the field, what is the size of the field? The problem must be solved by mental arithmetic.

"I'd like to have friend Torrance tell you how he found the size of that field," continued the Professor. "Before he returned to Cuba, he told me how he solved it when a mere boy. But in his absence I'll ask Cal Klater instead, for I recall that he had his hand up in about one minute after the problem was stated."

"Here's how I did it, Professor Neare. I divided that square field into triangles each bounded by one chain of fence and two radial lines to the center of the square. Since each triangle has the same base, altitude, and area, each must have as many boards as acres. Now one chain of fence must have 6 × 4 = 24 boards, and 24 acres equal 240 square chains.



Each base being one chain, each altitude must be 480 chains, or six miles. Therefore the field must be 12 miles square. Mr. Torrance just asked for the size of the field, not the area in acres."

"Quite right, Cal, and your method was just like his, only he wor!:ed in rods. If the field were circular or hexagonal, the diameter would also be 12 miles, but some of the boards would be fractional.

"I have a new problem which defies mental arithmetic, though stated in disarmingly simple terms. It was given me by a navigator who received this order in maneuvers:

" 'The U.S.S. *Swing* will convoy the U.S.S. *Pivot*, which is holding 20 knots on course one eight zero. Proceed at constant speed so as to maintain interval of five miles from convoy and to encompass it once each hour.'

"The navigator (the late Eugene Herzinger, Lieutenant-Commander, U.S. Navy) determined the required speed by trial on his plotting board. You will agree with me that he wouldn't have had time for the analytical solution."

[Professor N. G. Neare wishes to express his admiration for a contributor who sent him a general solution for the August problem of the Dictators and the Cocoanuts, not just for his able mathematics but for his brilliant foresight. Who indeed can foretell whether the day of reckoning will find Pink, Green, and Violet Dictators added to the exiles or whether cannibalism will have reduced their number to two or even one?

Letting n = the number of nuts, c/d = the proportion abstracted by each dictator from the pile he found, k = the remainder after each subdivision, m = the number of dictators, and a = the number of nuts in each final subdivision, he found:

$$cn(d - c)^m = 2acmd^m + kd^{m+1} - k(d - c)^{m+1}$$

For the August problem, $c = 2$, $d = 5$, $m = 4$, and $k = 1$, so that

$$162n = 10{,}000a + 2{,}882$$

and the contributor, Director E. P. Goodrich, continued the particular solution to find $n = 1{,}561$.]

Military Departments Continue to Call Reserve Officers

RECENT announcements in CIVIL ENGINEERING of members of the Society in the U.S. Naval Reserve and in the Officers Reserve Corps of the Army who have been ordered to report for active duty may now be supplemented. Of the Naval Reserve there are Lt. Comdr. Robert C. Johnson from Boynton and Johnson, Milwaukee, Wis., to the Naval Air Station at San Juan, P.R.; Lt. Comdr. Francis A. Rossell to the Navy Yard at New York City; Lt. Harlan F. Winn from instructor in civil engineering at Iowa State College to the Naval Station at Key West, Fla., where he is assistant public works officer; Lt. Oliver W. Munz from assistant civil engineer for the U.S. Forest Service at Milwaukee, Wis., to the Thirteenth Naval District at Seattle, Wash.; Lt. Joseph C. Luppens from engineer in charge of the Specifications Section of the U.S. Engineer Office at Binghamton, N.Y., to the Thirteenth Naval District; and Lt. Robert W. Hollis, Jr., from assistant engineer for the California Railroad Commission at San Francisco, Calif., to the Thirteenth Naval District.

Similarly, of the Officers Reserve Corps, there are Lt. Col. Cleveland B. Coe from associate highway engineer for the TVA at Chattanooga, Tenn., to six months' active duty with the army at the headquarters of the First Military Area at Knoxville, Tenn.; Maj. Alexander C. Knight from the Knight Engineering Company at Louisville, Ky., to the Office of the Quartermaster General in the Construction Division of the War Department; Capt. Charles B. Ferris from engineer in charge of the architectural department of the Mutual Life Insurance Company, New York, N.Y., to the 102d Engineers at Camp McClelland, Anniston, Ala.; and Capt. Ervin Greenbaum from public works engineer for the Michigan State Highway Department at Lansing, Mich., to the Detroit Ordnance District at Detroit, Mich.

Tablet to Calvin Winsor Rice Unveiled

THE memory of Calvin Winsor Rice, for many years secretary of the American Society of Mechanical Engineers, was honored by that organization on December 2, when a tablet was unveiled in the lobby of the Engineering Societies Building. The inscription states that the tablet was "erected in appreciation of a life devoted to the advancement of the profession of engineering and of his active part in obtaining from Andrew Carnegie the gift of the Engineering Societies Building."

In the dedication ceremonies Charles F. Scott, former president of the American Institute of Electrical Engineers, stated that Mr. Rice's great contribution to the profession "lay in his understanding of the role engineers and engineering should play in our modern civilization," and stressed his achievement in expanding the American Society of Mechanical Engineers into a national organization. Mr. Rice died in 1934.

Long-Time Study of Cement Performance in Concrete

THE Portland Cement Association is undertaking a long-time study of the performance of cement in concrete. The program to be followed has been developed by an advisory committee of twelve, which includes the following members of the Society: Byram W. Steele, J. L. Savage, P. J. Freeman, T. E. Stanton, Roy W. Carlson, F. R. McMillan, and Frank T. Sheets.

The objectives of the study will be the determination of the extent to which the performance of concrete is affected by differences in cement, and the factors responsible for such differences. Variations in concreting methods and workmanship are, in general, to be avoided.

The cements selected for these studies fall, in general, into the five types defined by tentative A.S.T.M. Specification C150-40T with an extra group to cover specially treated cements (ground with tallow, Vinsol resin, etc.). The field work will consist of ten major projects located in different parts of the country so that a wide variety of conditions of soil, weather, and materials will be encountered. Three of the principal projects will be experimental pavements constructed, in cooperation with state highway departments, under standard procedures in which cements representing the five standard types and the treated cements will be used

Two projects, similar to the above and in conjunction with them, will study variations in consistency and exposure with treated and untreated cements. Three projects will study effects of variations in fineness of cement and in burning and cooling conditions of the clinker. One project will be carried out at two locations, where the effect of soils high in sodium sulfate and magnesium sulfate, respectively, may be studied, and another will study the effect of fresh and sea waters on the six types of cement, using reinforced concrete piles of normal cross section and length.

Colonel Somervell, Corps of Engineers, Heads Quartermaster Construction Division

Transferred to duty with the Quartermaster Corps, Lt.-Col. Brehon B. Somervell, M. Am. Soc. C.E., has been appointed chief of the Construction Division in the office of the Quartermaster General. He replaces Brig. Gen. Charles D. Hartman, who has had to enter Walter Reed Hospital for treatment.

Until recently Colonel Somervell was actively engaged as WPA Administrator in New York City. In his new position with the Quartermaster Corps he will be responsible for "pushing" the $1,147,000,000 War Department construction program.

New Bulletins in Boulder Dam Series

Three additional bulletins have been issued by the U.S. Bureau of Reclamation as official records on the Boulder Canyon Project. As part of the comprehensive description that is being prepared on this great engineering project, these volumes will be welcomed by engineers. The new bulletins are:

- Part V. Technical Investigations
  - Bulletin 5, "Penstock Analysis and Stiffener Design"
  - Bulletin 6, "Model Tests of Arch and Cantilever Elements"
- Part VII. Cement and Concrete Investigations
  - Bulletin 1, "Thermal Properties of Concrete"

Bulletin 5, Part V, as its title implies, presents the theoretical and mathematical processes used in designing the penstocks and stiffener rings, including considerations of fillet inserts, conical shells, and other special details of design. The mathematical studies were supplemented by tests on a model of one of the penstocks, and a comparison between calculated and measured stresses is included. Methods for computing water-hammer pressures in compound pipes are described and illustrated by sample calculations.

Bulletin 6, Part V, presents the results of the tests of horizontal and vertical slab sections of Boulder Dam. Stresses were computed from measured strains and compared with the results of the mathematical analyses of non-linear stress conditions in the slab elements. Derivations of stress-strain relations and methods of computing stresses from strain measurements are also included. The models were made of plaster-celite materials, mixed and poured into forms in a manner similar to that used in concrete construction.

Bulletin 1, Part VII, presents the results of tests made to determine values of conductivity, specific heat, and diffusivity of concrete, for use in designing and controlling the construction of Boulder Dam. The investigations included studies of the relationship between thermal properties of various concrete mixtures and their individual constituents. The mathematical formulas needed in analyzing the test data and in calculating the flow of heat are developed in a special chapter. Verifications of the methods and equations used in the investigations were obtained by calculating temperature conditions in existing dams where field measurements of actual concrete temperatures were available.

The price of all three bulletins is $1.00 for paper-bound copies and $1.50 for cloth-bound, in the United States, Canada, and Mexico (elsewhere 10% higher). Orders may be addressed to the Bureau either at Denver or at Washington, D.C. Remittance must be by money order—stamps not accepted.

Brief Notes

H. George Altvater, Assoc. M. Am. Soc. C.E., calls attention to the interesting fact that when George Washington resigned as Commander-in-Chief of the Army, he resumed the simple title of "Engineer."

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The new (fifth) edition of *Who's Who in Engineering* is in preparation under the guidance of a committee comprising prominent engineering educators and the representatives of major engineering organizations, including the American Society of Civil Engineers. Engineers throughout the country are receiving material, questionnaires, and previously printed records relating to the items to be used.

* * * *

Motion pictures showing the contortions of the Tacoma Narrows Bridge just before and during the failure, have been placed on the commercial market and should be available at most local photography shops throughout the country.

* * * *

Developments toward which the activities of the Welding Research Committee of the Engineering Foundation have contributed during the last year are summarized in the committee's annual report, issued in December. The subjects on which papers have been published include such items as aspects of resistance welding, the weld puddle, shrinkage stresses, fatigue and creep, copper welding, hard facing, and many others. Committees of the Industrial Research Section also report important results dealing with uses of numerous alloys, methods of testing, and special analyses.

* * * *

An evidence of increasing cooperation between engineers throughout the new world is the fact that the October *Revista* of the Cuban Society of Engineers prints a translation into Spanish of the paper on ethics by Daniel W. Mead, Hon. M. Am. Soc. C.E., which appeared in the Proceedings of the American Society of Civil Engineers for January 1940. The translation was made by Prof. Francisco Gaston, M. Am. Soc. C.E., President of the Cuban Society of Engineers.

* * * *

A bibliography of hydrology, listing articles and books published on all phases of the subject in the United States in 1939, has been released by the American Geophysical Union, Washington, D.C., and is available from that organization at 50 cents a copy. Most of the 400-odd titles cataloged are accompanied by brief résumés which, together with the classification system employed, make the volume especially helpful and easy to use.

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At the 21st Annual Meeting of the National Council of State Boards of Engineering Examiners, held in Charleston, S.C., October 28–31, the following officers were announced for the coming year: president, Virgil M. Palmer, Rochester, N.Y.; vice-president, C. C. Knipmeyer, Terre Haute, Ind.; past-president, A. C. Polk, M. Am. Soc. C.E., Birmingham, Ala.; director from Western Zone, H. T. Person, M. Am. Soc. C.E., Laramie, Wyo.; director from Central Zone, Roy M. Green, M. Am. Soc. C.E., Lincoln, Nebr.; and director from Northeast Zone, W. W. Hodge, Morgantown, W.Va. T. Keith Legaré, M. Am. Soc. C.E., continues as executive secretary for his eighteenth term. Among other business transacted, a resolution was adopted recommending that all engineering societies promote action in their states to insure that the funds derived from fees paid by engineers for legal registration and renewal be expended under the control of the state registration board only for state or national activities connected with registration.

* * * *

Closely cooperating in the development of the program for training defense personnel is the Advisory Committee on Engineering Training for National Defense. The appointment of this committee was announced on September 26 by John W. Studebaker, U.S. Commissioner of Education. Among its membership are the following Society members: H. P. Hammond, dean of the School of Engineering, Pennsylvania State College; Thorndike Saville, dean of the College of Engineering, New York University; Gibb Gilchrist, dean of engineering, Agricultural and Mechanical College of Texas; W. O. Hotchkiss, president of Rensselaer Polytechnic Institute; and C. C. Williams, president of Lehigh University.

NEWS OF ENGINEERS

Personal Items About Society Members

C. R. COMPTON, formerly office engineer for the Los Angeles County (California) Sanitation Districts, has been advanced to the position of assistant chief engineer.

DONALD C. SCOTT is now city manager of Phoenix, Ariz. He previously maintained a consulting practice in that city.

SAMUEL S. BAXTER, who has been in the employ of the city of Philadelphia for the past fifteen years, has been made assistant director of public works for the city.

PHILIP G. BRUTON, lt. col., Corps of Engineers, U.S. Army, has been ordered to Newfoundland to do the preliminary work on the defense bases to be constructed there. Until recently Colonel Bruton was stationed at Buffalo, N.Y., where he was district engineer.

ROLAND GAIL BAKER was recently appointed city engineer of Phoenix, Ariz.

MALCOLM ELLIOTT, colonel, Corps of Engineers, U.S. Army, now division engineer of the Upper Mississippi River Division of the U.S. Engineer Office, will assume additional duties as division engineer of the Missouri River Division. He will divide his time between St. Louis and Kansas City, where the two division offices are located.

JACK CHARLES MORGAN, formerly on the engineering staff of New York University, has accepted a position as engineer inspector on construction and maintenance with the Standard Oil Company of New Jersey.

GLEN C. BICKLEY is now highway engineer of Chisago County, Minnesota.

RALPH O'NEILL has been transferred from the South Dakota Planning Survey to the South Dakota State Highway Department, where he will be employed on bridge design.

LESSLIE R. THOMSON, consulting engineer of Montreal, Canada, has been appointed associate economic adviser to the Department of Munitions and Supply at Ottawa, Canada.

H. G. SOURS, assistant director of the Ohio State Highway Department, has been named acting director. Mr. Sours is president of the American Road Builders' Association.

KARL A. SINCLAIR, former PWA administrator for Hawaii, is now maintenance engineer with the Hawaii Department of Public Works.

DAVID W. GODAT has severed his connection as maintenance engineer for the New Orleans Division of Public Works and, in conjunction with C. C. BARNARD and G. A. HEFT, formed the consulting engineering firm of Barnard, Godat and Heft. The firm will specialize in structures, drainage, municipal engineering, and public utilities.

ROBERT E. NEUMEYER, previously district engineer for the Pennsylvania State Highway Department, is now executive director of the Bethlehem Housing Authority, with headquarters in Bethlehem, Pa.

HOWARD F. CLARK, lieutenant colonel, Corps of Engineers, U.S. Army, has been transferred from duty as instructor for the Engineer Regiment of the Idaho National Guard and assigned to duty at the Engineer Replacement Center, Fort Belvoir, Va.

SAMUEL SHULITS is now chief engineer of the Engineer Department Research Centers of the U.S. Waterways Experiment Station at Vicksburg, Miss. His previous assignment was a preliminary flood control examination of the Wabash River and tributaries for the U.S. Engineer Office at Louisville, Ky.

CARL STEPHENS ELL, former vice-president and dean of Northeastern University at Boston, Mass., was inaugurated second president of the university in the Boston Opera House on the afternoon of November 19. In the evening there was an inaugural dinner, at which Karl T. Compton, president of the Massachusetts Institute of Technology, was the principal speaker.

WINTERS HAYDOCK has accepted the position of Regional Defense Housing Coordinator for the Advisory Commission of the Council of National Defense, with headquarters in Washington, D.C. He was formerly acting regional director for the U.S. Housing Authority at San Francisco, Calif.

RUDARD A. JONES, until recently architectural and structural draftsman for Lee Black and Kenneth C. Black of Lansing, Mich., is now assistant professor of structural design at Kansas State College.

D. L. ERICKSON, in addition to his work as city engineer of Lincoln, Nebr., now has the position of director of parks, public property, and improvements.

MARK G. SANTI has been transferred from the Federal Power Commission to the Civil Aeronautics Administration and appointed to the Federal Airways Division, with headquarters in Washington, D.C.

HARRY B. VAUGHAN, JR., district engineer for the U.S. Engineer Office at Philadelphia, Pa., has been promoted from the rank of major in the Corps of Engineers, U.S. Army, to that of lieutenant colonel.

LEONARD C. URQUHART, professor of structural engineering at Cornell University, is teaching at the University of Hawaii in Honolulu while on a half-year sabbatical leave.

EDWARD D. GRAFFIN, Commander, Civil Engineering Corps, U.S. Navy, has been relieved from duty at the New York Navy Yard and assigned to duty as public works officer at the Naval Air Station, Pensacola, Fla.

ROBERT L. MACDOUGALL, of Atlanta, Ga., has been appointed regional director of Region 5 for the Works Progress Administration. Region 5 includes Alabama, Florida, Georgia, Kentucky, Tennessee, and North and South Carolina.

PAUL D. BENNETT is now assistant professor of military science and tactics at Rose Polytechnic Institute. He was formerly with the Chicago, Milwaukee, St. Paul and Pacific Railroad.

PERRY A. FELLOWS has been promoted from the position of assistant chief engineer for the Works Progress Administration to that of chief engineer. His headquarters are in Washington, D.C. Mr. Fellows' appointment comes after seven years of service with the federal works program.

CHARLES F. KETTERING, vice-president and director of General Motors Corporation and general director of the General Motors Research Corporation, was awarded the A.S.M.E. Medal at the annual dinner of the American Society of Mechanical Engineers held in New York City on December 4. The medal, the highest honor of the society, was awarded Mr. Kettering "for his long and pronounced influence on automobile development." Mr. Kettering's many inventions include the automobile self-starter and the Delco-lighting system.

CHARLES H. MITCHELL has announced that he will retire as dean of engineering at the University of Toronto at the end of the present academic session. At that time he will have served as dean for twenty years. General Mitchell is a former president of the Engineering Institute of Canada and has, for many years, maintained a consulting practice in Toronto.

WALKER R. YOUNG, supervising engineer for the U.S. Bureau of Reclamation on the Central Valley Project in California, has been promoted to the position of assistant chief engineer of the Bureau, with headquarters in Denver, Colo. He is succeeded as acting supervising engineer on the Central Valley Project by ROBERT S. CALLAND, formerly assistant supervising engineer.

EARL I. BROWN, colonel, Corps of Engineers, U.S. Army, who retired in 1938, has been temporarily recalled to active duty to act as district engineer at the Wilmington (N.C.) office.

WILLIAM BENJAMIN GREGORY was awarded the Worcester Reed Warner Medal of the American Society of Mechanical Engineers during the 61st annual meeting of the society. The award is made annually "for contributions to permanent engineering literature." Prior to his retirement in 1938 Dr. Gregory had been a member of the engineering faculty of Tulane University for forty-four years.

ULYSSES S. GRANT, 3d, colonel, Corps of Engineers, U.S. Army, has been transferred to Chicago from Cleveland, where he has been serving as division engineer.

O. H. AMMANN, director of engineering for the Port of New York Authority; THEODOR VON KÁRMÁN, director of the Daniel Guggenheim Aeronautical Laboratory at California Institute of Technology;

and GLENN B. WOODRUFF, engineer of Berkeley, Calif., have been appointed a three-man board by the Public Works Administration to study the failure of the Tacoma Narrows Bridge. Two other members of the Society—L. J. SVERDRUP and RUSSELL G. CONE—are members of the board named by the Washington Toll Bridge Authority to estimate the damage to the bridge in order to aid the Authority in making its claims for insurance.

LAWRENCE R. YOUNG has severed his connection with the U.S. Engineer Office at Little Rock, Ark., in order to join the hydraulic division of the Aluminum Company of America.

BURGE B. KEPFORD recently resigned as draftsman for the Wyoming State Highway Department to accept employment as senior engineering aid with the U.S. Bureau of Reclamation, with headquarters at Green River, Wyo.

WILLIAM E. R. COVELL is now general manager of the Crossett-Watzek-Gates Industries, with headquarters at Crossett, Ark. He was formerly assistant to the general manager.

THOMAS N. CREACY, formerly with Consolidated Builders, Inc., of Mason City, Wash., has accepted a position with the Puget Construction Company on the addition to the Bonneville power house.

ARTHUR C. CRAWSHAW has left the employ of the City of San Francisco to accept a position as an estimator for contractors engaged in the construction of naval air bases in the Pacific. His headquarters are in Honolulu, T.H.

EDWARD BARTOW, professor and head of the department of chemistry and chemical engineering at the University of Iowa, has been granted a leave of absence to join the research laboratories of the Johns-Manville Corporation at Manville, N.J.

FLOYD W. HOUGH is now retained by the Colombian Petroleum Company at Cucuta, Colombia, as engineer in charge of geodetic work for that company on the Barco Concession. Mr. Hough was formerly in the U.S. Engineer Office at Pittsburgh, Pa.

DECEASED

LAYSON ENSLOW ATKINS (M. '40) district engineer for the Seattle District of the U.S. Engineer Office, Seattle, Wash., died on September 17, 1940. Colonel Atkins, who was 47, was with the Corps of Engineers of the U.S. Army for many years. He had been stationed in Louisville, Ky., and Washington, D.C., and had served as chief engineer of the Alaska Road Commission and as chief of the Supply Section in the office of the Chief of Engineers. During the war Colonel Atkins was with the 14th Engineers, operating light railways in France.

LINCOLN BUSH (M '05) Past-President and Honorary Member of the Society, died in East Orange, N.J., on December 10, 1940, at the age of 80. A brief biography and photograph of Colonel Bush appear in the Society Affairs section of this issue.

ERNEST EARLE CLUTTER (Assoc. M. '26) of New York, N.Y., died recently at the age of 61. Mr. Clutter was structural designer for the New York State Public Service Commission from 1913 to 1917; for the Boston and Maine Railroad from 1918 to 1919; and for the American Water Works and Electric Company from 1917 to 1918 and, again, from 1922 to 1925. At one time, also, he maintained a private practice in Philadelphia, and he had been with the American Cyanamid Company and the TERA in New York.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

ALBERTO DECOMBE (M. '31) of Santiago, Chile, died on February 18, 1940, though word of his death has just reached Society Headquarters. Professor Decombe, who was 63, was with the Department of Public Works of Chile from 1908 until his death—as director of reclamation since 1915. During this period he also served as professor of railways and highways at the Catholic University of Santiago, and he acted as consulting engineer for American firms on various South American projects.

ANTON FREIHOFNER (Assoc. M. '27) of Flushing, N.Y., died on September 22, 1940, at the age of 65. Mr. Freihofner was born and educated in Vienna, and engaged in engineering work in Belgium, Hungary, and other European countries. In 1922 he came to the United States, where he was for some years with Alexander Potter, New York City consulting engineer, engaged on the design of water supplies for various American cities.

THOMAS TRIPLETT HUNTER HARWOOD (M. '10) of Rockport, Mass., died there on November 21, 1940, at the age of 76. From 1883 until his retirement Mr. Harwood was in the U.S. Engineer Office, serving successively as draftsman, inspector of construction, assistant engineer in the Boston office, and (from 1897 on) in immediate charge of all river and harbor work in the Boston Engineer District.

HENRY JULIUS KALTENBACH (Affiliate '02) of Yonkers, N.Y., died in New York City on November 12, 1940, at the age of 79. In 1875 Mr. Kaltenbach began his business career as office boy with Fleischmann and Company, manufacturers of yeast, advancing ultimately to the position of vice-president. He retired in 1930. Long a resident of Yonkers, he was vice-president of the First National Bank, which he founded in 1934; president of the Yonkers General Hospital; and a director of the Yonkers Welfare Federation.

EDWARD CHARLES KOPPEN (M. '28) construction engineer for the U.S. Bureau of Reclamation on the Salt River Project at Phoenix, Ariz., died there on November 26, 1940, at the age of 61. Mr. Koppen was assistant engineer for the Bureau of Reclamation from 1909 to 1924; hydraulic engineer for the California Oregon Power Company from 1925 to 1935; and construction engineer for the Bureau from 1935 on. Earlier in his career he was with the Corps of Engineers in the Philippines, and on the Canton-Hankow Railroad in China.

JAMES MICHAEL OWENS (Assoc. M. '08) highway engineer in the City Engineer's Office at San Francisco, Calif., died recently at the age of 65. Mr. Owens had been in the City Engineer's office since 1902, having served, successively, as draftsman, assistant to the assistant engineer, assistant engineer in charge of pavement design, and (since 1921) highway engineer. Prior to that he was with the Pacific States Telephone and Telegraph Company.

VICTOR HENRY POSS (M. '10) structural engineer of San Francisco, Calif., died on November 16, 1940, at the age of 70. Mr. Poss was in private engineering practice from 1910 to 1918 and, again, from 1921 until his death. He designed a number of steel bridges and mercantile buildings and the hull of the concrete ship "Faith." He also designed the Government Island (Oakland, Calif.) Shipyard for the San Francisco Shipbuilding Company.

ROBERT WILSON REED (Assoc. M. '21) president and manager of G. O. Reed, Inc., Miami Beach, Fla., died recently. Mr. Reed, who was 54, was connected with G. O. Reed, Inc., from 1923 on—first as general manager at Michigan City, Ind., and, later, as president and manager at Miami Beach. Earlier in his career (1916 to 1923) he was superintendent for the Great Lakes Dredge and Dock Company at Buffalo, N.Y.

SAMUEL STRUMER (Assoc. M. '38) chief engineer of the Division of Buildings of the New York City Department of Housing and Building, died in a hospital at Stapleton, S.I., on December 7, 1940. He was 46. Following his graduation from Cornell in 1917, he served overseas as a first lieutenant with the 48th Artillery. Later he was commissioned a captain in the Coast Artillery Reserve Corps and, in 1930, became a major. An early student of anti-aircraft problems, he was an instructor from 1925 to 1933 in anti-aircraft artillery for reserve officers. His last command was with the 910th Coast Artillery.

MARSHALL WILLIAMS (M. '14) of Pittsburgh, Pa., died on December 5, 1940, at the age of 67. Mr. Williams entered the employ of the Pencoyd Iron Works (later taken over by the American Bridge Company) in 1898, and from that date until his retirement in June 1940 he was continuously with the latter company. During his long service with that organization he held various executive positions, and at the time of his retirement was assistant to the president.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From November 10 to December 9, 1940, Inclusive

Additions to Membership

Aaron, Reid Stanley (Jun. '40), Chainman, Eng. Dept., N. & W. Ry. (Res., 1030 Kinneys Lane), Portsmouth, Ohio.

Addington, Martin Ratliff (Assoc. M. '40), Surveyman, U.S. Engrs. Office, Honolulu, Hawaii.

Amos, Bruce Logue (Jun. '40), Engr., Fluor Corp., Ltd., 704 Fairfax Bldg., Kansas City, Mo. (Res., 720 North 5th, Arkansas City, Kans.)

Anderson, Bruce Grant (Jun. '40), Chainman G.N. Ry. (Res., 334 Central), Whitefish, Mont.

Anderson, Dean Myrin (Jun. '40), With State Highway Dept., 1246 University Ave. (Res., 1222 Lafond Ave.), St. Paul, Minn.

Anton, Joseph (Jun. '40), Chainman, Illinois Central R.R., Millington, Tenn.

Aquino, Michael Thomas, Jr. (Jun. '40), 1901 Eighty-Fourth St., Brooklyn, N.Y.

Ash, Charles Robert (Jun. '40), 330 South Charles St., Lima, Ohio.

Bacon, Vinton Walker (Jun. '40), Eng. Aide, East Bay Cities Sewage Disposal Survey, Disposal Survey, City Hall (Res., 2639 College Ave.), Berkeley, Calif.

Bain, Jarvis Johnson (M. '40), Col., Corps of Engrs., U.S. Army, 1415 Central National Bank Bldg., Richmond, Va.

Bartlett, Joseph Kingsbery (Jun. '40), With Woermann Constr. Co., 3800 West Pine, St. Louis (Res., 4 Oak Terrace, Webster Groves), Mo.

Battle, Joe Marshall (Jun. '40), Rodman, State Highway Dept., Mount Pleasant, Tex.

Bauer, Emil Donald (Jun. '40), Draftsman, Glenn L. Martin Co., Middle River (Res., 2908 Winchester St., Baltimore), Md.

Bedd, Edward Kent (Jun. '40), 107 Primrose St., Chevy Chase, Md.

Benjamin, Jack Ralph (Jun. '40), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

Bensin, Fred Julius (Jun. '40), Engr., C. W. Lauman & Co., Inc., 50 Church St., New York (Res., 8533 One Hundred and Twelfth St., Richmond Hill), N.Y.

Bernat, Harry Jacob (Assoc. M. '40), Asst. Supt., Marine Constr., Brown-Bellows-Columbia, Naval Air Base, Corpus Christi, Tex.

Bittenbender, Robert Austin (Jun. '40), Stress Analyst, Curtiss Aeroplane Div., Curtiss-Wright Corp., Kenmore Ave. (Res., 282 North St.), Buffalo, N.Y.

Blankley, Roland Gunder (Jun. '40), Junior Eng. Examiner, Examining Div., Civ. Service Comm., 930 F St., N.W. (Res., 616 Randolph St., N.W.), Washington, D.C.

Borgquist, Neil Erasmus (Jun. '40), Hydrographer, Water Dept., Room 319 City Hall (Res., Y.M.C.A.), Pasadena, Calif.

Boyer, Walter Charles Bernard (Jun. '40), 2519 East Madison St., Baltimore, Md.

Boyles, Richard Hamilton (M. '40), Engr., Fox Chapel Authority, Fox Chapel Rd., Pittsburgh, Pa.

Brady, William Henry (Jun. '40), Junior Engr., Pipeline Dept., Standard Oil Co. of California, Box 1500, Bakersfield, Calif.

Brewster, Edward Dodd (Assoc. M. '40), Dist. Mgr., The Armco International Corp., Palma a Miracielos 38, Caracas, Venezuela.

Burgess, Lloyd Albert (Jun. '40), Junior Layout Man, Douglas Aircraft Corp., El Segundo (Res., 2416 Grandview Ave., Venice), Calif.

Burk, Peter William, Jr. (Jun. '40), Student Engr., Corps of Engrs., War Dept., Los Angeles Dist. Office, 751 South Figueroa St. (Res., 1011 West 8th St.), Los Angeles, Calif.

Callahan, Ezra Leo (Assoc. M. '40), Structural Engr., A.T. & S.F. Ry., 751 Kerckhoff Bldg., N.E., Los Angeles (Res., 3906 West 111th Pl., Inglewood), Calif.

Campbell, Robert Russell (Jun. '40), Student Hydr. Engr., U.S. Engrs., War Dept., 751 South Figueroa St. (Res., 3755 Cardiff Ave.), Los Angeles, Calif.

Cavanagh, Gerard Joseph (Jun. '40), Wilder Apartments, Corvallis, Ore.

Chapman, John Spence Hayes (Jun. '40), Stress Analyst, Glenn L. Martin Co. (Res., 2421 Maryland Ave.), Baltimore, Md.

Chenea, Paul Franklin (Jun. '40), Junior Engr., Hawaiian Raymond Turner Co., Drawer F, Alameda (Res., 2136 Ward St., Berkeley), Calif.

Clark, Joseph Miller (Jun. '40), Foreman, List & Clark Const. Co., 414 Railway Exchange Bldg., Kansas City, Mo.

Cleveland, Norman Bower (Jun. '40), Structural Engr., Jackson & Moreland, Park Sq. Bldg., Boston (Res., 9 Ray St., Beverly), Mass.

Collins, Frank Bell (Jun. '40), Junior Engr., Indiana Ordnance Works, Charlestown (Res., 1314 East Oak St., New Albany), Ind.

Comstock, William Phillips, Jr. (Jun. '40), Care, College of Eng., New York Univ., University Heights, New York, N.Y.

Converse, Frank Porter, Jr. (Jun. '40), 11871 Lake Ave., Lakewood, Ohio.

Corcoran, William Joseph (Jun. '40), Estimator, J. Slotnik Co., 91 Newbury St., Boston (Res., 17 Bentley St., Brighton), Mass.

Cranford, Leonard Carter (Jun. '40), Asst. Supervisor, Grade 4, Washington National Airport, Gravelly Point (Res., 73 Rhode Island Ave., N.W.), Washington, D.C.

Culpepper, Fred Carroll, Jr. (Jun. '40), Rodman, United Gas Pipe Line Co. (Res., 106 Grayling Ave.), Monroe, La.

Daggett, Robert Eugene (Jun. '40), With Carnegie-Illinois Steel Co., Gary Works, Gary, Ind. (Res., 601 Campbell St., Joliet, Ill.)

Dalgleish, Charles Edwin (Jun. '40), Junior Eng. Aid, Div. of Highways, Box 911, Marysville (Res., Lower Lake), Calif.

Davidson, Donald Thomas (Jun. '40), Research Graduate Asst.-Highway Engr., Eng. Experiment Station, Iowa State College, Ames, Iowa.

Davies, Joseph Herbert (M. '40), Cons. Engr., 803 Ocean Center Bldg., Long Beach, Calif.

Davis, Berry Fredrick (Jun. '40), Checker, State Highway Dept., Greenville Ave. (Res., 500 East 5th St.), Dallas, Tex.

Davis, Harold Shelley (Jun. '40), 90½ Murray St., Binghamton, N.Y.

Davis, William Barry (Jun. '40), Asst. Engr., State Board of Health, Univ. of Kansas, Lawrence (Res., 1313½ North Washington, Hutchinson), Kans.

Diven, James Barry, Jr. (Assoc. M. '40), Care, E. I. du Pont de Nemours & Co., Baton Rouge, La.

Djivelekoglu, Shahan (Jun. '40), Research Asst., Civ. Eng., Univ. of Michigan (Res., 439 South Division St.), Ann Arbor, Mich.

Dougherty, Gale Barkman (Jun. '40), Student Engr., U.S. Engrs. (Res., 1211 Roswell), Long Beach, Calif.

Driver, Paul Robert (Jun. '40), Student Engr., Jones & Laughlin Steel Service, Inc., 30–44 Review Ave., Long Island City (Res., 5 West 63d St., New York), N.Y.

TOTAL MEMBERSHIP AS OF DECEMBER 9, 1940	
Members	5,668
Associate Members	6,513
Corporate Members	12,181
Honorary Members	36
Juniors	4,366
Affiliates	69
Fellows	1
Total	16,653

Dudley, Robert Arthur (Jun. '40), Transitman, State Highway Dept., Montpelier (Res., Bradford), Vt.

Edelman, Ira Daniel (Jun. '40), Draftsman, Snead & Co., 96 Pine St. (Res., 102 Wade St.), Jersey City, N.J.

Edwards, Stacy Wright (Jun. '40), Regional San. Engr., State Dept. of Health, City Hall, Kerrville, Tex.

Elson, Charles Robert (Jun. '40), Asst. Road Designer, State Highway Comm., State House Annex (Res., 1512 North Meridian St., Apt. 19), Indianapolis, Ind.

Erdle, John Francis (Jun. '40), West 2438 Pacific, Spokane, Wash.

Esch, James George, Jr. (Jun. '40), Field Insp., Sun Oil Co., 2117 National Bank Bldg., Detroit, Mich.

Evans, Henry King (Jun. '40), Traffic Engr., Automobile Club of Southern California, 2601 South Figueroa, Los Angeles, Calif.

Ewell, Walter Worthington (Jun. '40), 2525 Reisterstown Rd., Baltimore, Md.

Falkin, Murray (Jun. '40), Junior Engr., Lynn Const. Co., 11 West 42d St., New York (Res., 1280 East 18th St., Brooklyn), N.Y.

Farr, Donald Joseph (Jun. '40), Asst. Sign and Traffic Supervisor, State Highway Dept., Santa Fe (Res., 429 North Maple, Albuquerque), N.Mex.

Fegan, Joseph Clifford (Jun. '40), 1906 G St., N.W., Washington, D.C.

Fellows, Roy Carol (Jun. '40), Draftsman, Siems Drake Puget Sound, Dutch Harbor, Alaska.

Ferrell, James Orin (Jun. '40), Junior Asst., Carnegie-Illinois Steel Corp., 3400 East 89th (Res., 7337 Coles Ave.), Chicago, Ill.

Fisher, Charles Leahy (Jun. '40), Junior Engr., Housing Authority of New Orleans, Gibson and Milton Sts., New Orleans, La.

Fitzgerald, John Paul (Assoc. M.'40), Asst. Designer (Hull), Geo G. Sharp, 30 Church St., New York (Res., 35–35 Ninety-Fifth St., Jackson Heights), N.Y.

Florance, Kirk B. (Jun. '40), Rodman, Dept. of Roads and Irrig., State House, Lincoln (Res., Red Cloud), Nebr.

Forsthoff, Joseph Robert (Jun. '40), Asst. Engr., State of Ohio, State Highway Garage, Sidney (Res., 119 North Walnut St., Celina), Ohio.

Fox, George Arnold (Jun. '40), With U.S. Navy, Navy Yard (Res., 1837 Ocean Ave.), Brooklyn, N.Y.

Fry, Berwyn Joseph (M. '40), Chf. Engr., E. J. Albrecht Co., 2632 West 26th St., Chicago, Ill.

Fuquay, Archie Garth (Jun. '40), Junior Insp., State Highway Dept., College Drive (Res., 723 Orange St.), Abilene, Tex.

Gahr, William Nicholas (Jun. '40), Rodman, Eng. Dept., G.N. Ry. (Res., 1323½ University Ave.), Grand Forks, N.Dak.

Gaustad, Herbert Hewett (Jun. '40), Care, Kimberly-Clark Corp., 142 Third St., Neenah, Wis.

Godsey, Vernon Eldon (Jun. '40), 420 Wall St., Apt. 218, Seattle, Wash.

Goodman, Lawrence Eugene (Jun. '40), 706 West Iowa St., Urbana, Ill.

Goodrich, Frank Nobiling (Jun. '40), Junior Engr., Southern California Gas Co., 1700 Santa Fe, Los Angeles (Res., 315 South Washington, Whittier), Calif.

Graver, Robert William (Jun. '40), Detailer, Bethlehem Steel Co., Bell and Abby Sts. (Res., 149 Como Ave.), Buffalo, N.Y.

Green, Herbert Spencer (Jun. '40), Designer, Harza Eng. Co., 27 Cumberland St., Charleston, S.C.

Greene, Kenneth John (Assoc. M.'40), With Consolidated Aircraft Corp. (Res., 4608 Georgia St.), San Diego, Calif.

Gregory, Paul Duke (Jun. '40), Laboratory Asst., State Highway Dept. (Res., 406 West 15th St.), Austin, Tex.

Gundrum, Norman Henry (M. '40), Asst. Highway Engr., State Div. of Highways, Dept. of

Public Works and Buildings, Centennial Bldg. (Res., 1514 South 5th St.), Springfield, Ill.

Guercone, Santo Henry (Jun. '40), Instrumentman, Geo. A. Fuller Merritt, Chapman & Scott, Naval Air Station, Quonset Point (Res., 654 Elmwood Ave., Providence), R.I.

Guy, James Lamb (Jun. '40), Univ. of Tennessee, 907 Seventeenth St., Knoxville, Tenn.

Haggart, Robert Stevenson, Jr. (Jun. '40), Care, Geology Dept., Georgia School of Technology, Atlanta, Ga.

Hall, George Walter (Jun. '40), 1827 White Ave., Knoxville, Tenn.

Hamlin, William Gilbert (Jun. '40), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

Hanline, Charles Francis (Jun. '40), With Standard Oil Co. of Ohio, Midland Bldg., Cleveland, Ohio. (Res., 237 Deverill St., Ludlow, Ky.)

Hamlyn, Wilfred Thomas (Jun. '40), Office Engr., State Highway Dept. (Res., 902 Upson Ave.), El Paso, Tex.

Hansen, Harold Woodrow (Jun. '40), Student Highway Eng. Aide, State Highway Dept., 1246 University Ave., St. Paul (Res., 3232 Blaisdell Ave., Minneapolis), Minn.

Hansen, Warren Louis (Jun. '40), Surveyor, Lehigh Valley R.R., Ft. of Johnson Ave., Jersey City (Res., 71 Washington Ave., Irvington), N.J.

Hardy, William Lowther (Jun. '40), Chf. of Party, Henry F. Bryant & Son, White Pl., Brookline (Res., 42 Main St., Cochituate), Mass.

Harris, Henry Bullard, Jr. (Jun. '40), Draftsman, Union Bay & Paper Corp. (Res., 124 East State St.), Savannah, Ga.

Havenner, Joseph Estill (Jun. '40), Research Fellow, Bureau for Street Traffic Research, Yale Univ. (Res., 195 Whitney Ave.), New Haven, Conn.

Hawke, James Philip (Assoc. M. '40), Care, U.S. Engr. Dept., Customs House, Nashville, Tenn.

Hays, David Duncan (Jun. '40), Riverton, Wyo.

Heilman, John Elvin (Jun. '40), With Turner Constr. Co., 420 Lexington Ave., New York, N.Y. (Res., 724 North Lime St., Lancaster, Pa.)

Hettema, Robert Myron (Jun. '40), Asst., Turner Constr. Co., 420 Lexington Ave. (Res., 139 Payson Ave.), New York, N.Y.

Hicks, Fred Lloyd (Assoc. M. '40), Highway Draftsman and Designer, State Highway Dept., 2 Capitol Sq. (Res., 737 Yorkshire Rd., N.E.), Atlanta, Ga.

Hicks, William Delbert (Assoc. M. '40), Room 740 Midland Bldg., Cleveland, Ohio.

Hill, William Clyde (Jun. '40), Draftsman, Chicago Pump Co., 2336 Wolfram St. (Res., 949 Balden Ave.), Chicago, Ill.

Hinkson, Newton Lowell (Assoc. M. '40), Designing Engr., Harza Eng. Co., 27 Cumberland, Charleston, S.C.

Hitchcock, Clinton Arthur (Jun. '40), 262 North 9th St., Laramie, Wyo.

Hodosh, Herbert Richard (Jun. '40), 304 East 178th St., New York, N.Y.

Hogg, Edward Dominic (Jun. '40), Rodman, Gulf Research & Development Co., Box 150, Alexandria (Res., 8000 Nelson St., New Orleans), La.

Holland, Paul (M. '40), Asst. Road Engr., Board of Wayne County Road Commrs., 3800 Barlum Tower (Res., 17781 Northrop), Detroit, Mich.

Houk, Ivan Edgar, Jr. (Jun. '40), Junior Engr., U.S. Bureau of Reclamation, Friant, Calif.

Hoyt, Warren Hiram (Assoc. M. '40), Asst. City Engr., City Hall (Res., 1030 Forty-Fifth St.), Emeryville, Calif.

Hume, Virgil Lawrence (Jun. '40), Engr., T. J. Hume Co., 435 Hamilton Ave., Lorain, Ohio.

Husted, Harold Benjamin (Jun. '40), Draftsman, Am. Bridge Co. (Res., 610 Park Rd.), Ambridge, Pa.

Imboden, George Ralph (Assoc. M. '40), Town Mgr., Town Hall, Bloomfield, Conn.

Israelsen, Orson Allen (Jun. '40), Missionary, Church of Jesus Christ of Latter-day Saints, New England Mission, 7 Concord Ave., Cambridge, Mass. (Res., 329 Main St., Nashua, N.H.)

Kaysen, James Philo (Assoc. M. '40), Special Engr., C.M. St.P. & P.R.R., 321 West Everett St., Milwaukee (Res., 333 Center St., Cedarburg), Wis.

King, Ralph Wendon (Jun. '40), Structural Draftsman, Am. Bridge Co. (Res., 325 Elm Rd.), Ambridge, Pa.

Kolm, Roger Edward (Jun. '40), Stress Engr., Boeing Aircraft Co., Georgetown Substation (Res., 1800 McClellen), Seattle, Wash.

Krason, Ferdinand Carol (Jun. '40), Junior Civ. Engr., Dry Dock Associates, Norfolk Navy Yard, Portsmouth (Res., 41 Decatur St., Cradock), Va.

Krumholz, Morris Lucius (Jun. '40), Engr., S. Rabinowitz Iron Works, 199 Norfolk St., Newark, N.J.

Kruse, Charles Harold (Jun. '40), 580 Midgard Rd., Columbus, Ohio.

Ku, Hsien-Hsiang (Jun. '40), 801 Hayes St., West Lafayette, Ind.

Kunze, Albert Tenant (M. '40), San. Engr., Wayne County Road Comm., 3800 Barlum Tower, Detroit (Res., 144 Poplar St., Wyandotte), Mich.

Leeson, Elwood Richard (Jun. '40), Asst. Hydr. Engr., U.S. Geological Survey, Box 138, Rolla, Mo.

Lewis, Lester Marx (Jun. '40), Asst. Engr., Constr. Div., E. I. du Pont de Nemours & Co., Indian Head, Md. (Res., 3219 McKinley St., N.W., Washington, D. C.)

Lill, Wayne Percy (Jun. '40), Care, Magnolia Petroleum Co., Box 900, Dallas, Tex.

Loiselle, Donald William (Jun. '40), Asst. San. Engr., State Board of Health, State House (Res., 9 Hutchins St.), Concord, N.H.

Lonergan, Richard Philip (Jun. '40), Eng. Aide, East Bay Cities Sewage Disposal Survey City Hall, Berkeley (Res., 372 Twenty-Sixth Ave., San Francisco), Calif.

Lookup, Arthur Warner (Jun. '40), Structural Designer, Van Rensselaer P. Saxe, 100 West Monument St. (Res., 225 West Monument St.), Baltimore, Md.

McCreary, Adriel Raymond (M. '40), Archt. and Engr. (Fulton & McCreary), 5716 Euclid Ave., Cleveland, Ohio.

McEnary, Robert Reed (Jun. '40), Asst. Master Carpenter, G.N. Ry., Great Falls, Mont.

McEvoy, Robert William (Jun. '40), Draftsman, E. I. du Pont de Nemours & Co., Inc. (Res., Seaford Inn), Seaford, Del.

Makal, Thomas Joseph (Jun. '40), 1st Lt., Headquarters 2d Battalion, 121st Field Artillery, 32d Div., Camp Beauregard, La.

Manley, Harold Leonard (Jun. '40), Asst. Eng. Aid, U.S. National Bureau of Standards (Res., 3634 Jenifer St., N.W.), Washington, D.C.

Mansell, Bert Evan (Jun. '40), 286 Chestnut Hill Ave., Brighton, Mass.

Markel, Lyman Arthur (Assoc. M. '40), Associate Engr., U.S. Engr. Office, 751 South Figueroa St., Los Angeles, Calif.

Marshall, Charles Thomas (Jun. '40), Deputy Building Insp., City of Phoenix, City Hall (Res., 2542 North 9th St.), Phoenix, Ariz.

Marusich, Anton John (Jun. '40), Aggregate Insp., State Highway Dept., Box 126, Curtis (Res., Thomaston), Mich.

Matheu, Robert Richard (Jun. '40), Box 80, Submarine Base, Coco Solo, Canal Zone.

Matthaes, Jack Andrew (Jun. '40), Asst. Engr., State Highway Dept., 1851 Korbel, Columbus, Ohio.

Matthews, William James (Jun. '40), Senior Eng. Aid, U.S. Engrs., Berth 88, San Pedro (Res., 4622 East 3d St., Long Beach), Calif.

Mayer, Mayer, Jr. (Jun. '40), With Federal Barge Lines (Res., 826 Pecan St.), Helena, Ark.

Meals, Jasper Wade (Jun. '40), Engr., James McHugh, 6449 South Park Ave. (Res., 3154 Redwood Rd.), Chicago, Ill.

Meissner, Vernon Steven (Jun. '40), 300 Shafer Bldg., Seattle, Wash.

Melson, Lewis Byron (Jun. '40), 135 North 25th St., Corvallis, Ore.

Metzler, Dwight Fox (Jun. '40), Box 122, Manhattan, Kans.

Morgan, George (M. '40), Supt., Giffels & Vallet, Inc., Marquette Bldg. (Res., 600 Pingree St.), Detroit, Mich.

Morrissett, Marion Roberts (Jun. '40), Junior Engr., Seaboard Air Line Ry., Room 3 Union Station, Savannah, Ga.

Nelson, Clyde Edward (Jun. '40), 2028 Cleveland Blvd., Granite City, Ill.

Nelson, Floyd Leroy (Jun. '40), Junior Bridge Draftsman, Dept. of Roads and Irrig., State House (Res., 1245 Garfield), Lincoln, Nebr.

Newberg, Arthur Helmer (Jun. '40), Washington Univ., St. Louis, Mo.

Norton, John Kennedy (M. '40), Road Engr., Wayne County Road Comm., 3800 Barlum Tower (Res., 18890 Bretton Drive), Detroit, Mich.

Oksay, Ismail Melih (Jun. '40), 130 Esret Efendi Sok, Pangalti, Istanbul, Turkey.

Oltman, Roy Edwin (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, 808 New Post Office (Res., 1922 Berkeley Ave.), St. Paul Minn.

Orme, Samuel Avlin (Jun. '40), Squirrel Idaho.

Pappmeier, Louis Stahl (M. '40), Cons. Engr., 105 Chester Court, Peoria, Ill.

Pease, Russell Shepard (Jun. '40), Field Office Mgr., Merritt Chapman, Scott & George A. Fuller, Quonset Point (Res., 22 Beechwood Drive, East Greenwich), R.I.

Peltier, Fredric Eugene (Jun. '40), Test Engr., Worthington Pump & Machinery Corp., Harrison, N.J. (Res., 657 East 26th St., Brooklyn, N.Y.)

Peterson, Edward Wallace (Jun. '40), Draftsman, Guy F. Atkinson Co., Enumclaw, Wash.

Poulsen, Frank (Jun. '40), 2d Lt., U.S. Army, 3d Ordnance Co., Fort Lewis, Wash.

Provine, Robert Burton (Jun. '40), Camp G-101-N, Bloomfield, N.Mex.

Pyle, Milton Allender (M. '40), Asst. Prof., Civ. Eng., Univ. of Maryland (Res., 4609 College Ave.), College Park, Md.

Quebe, William Fred (Jun. '40), Engr., State Highway Comm., State House Annex Bldg., Indianapolis, Ind.

Rau, William Llewellyn, Jr. (Jun. '40), Sale Engr., Ludowici-Celadon Co., Chicago, 22 East 16th Ave., Columbus, Ohio.

Read, John Winship (Jun. '40), Student Engr. Panama R.R., Balboa Heights, Canal Zone.

Reed, George Dewey (Assoc. M. '40), Asst. Public Health Engr., U.S. Public Health Service, 617 Vine St. (Res., 3931 Plainville Rd.), Cincinnati, Ohio.

Reidy, Peter Joseph (Assoc. M. '40), Treas., Purdy & Henderson Associates, Inc., 45 East 17th St., New York, N.Y

Reiley Ralph Leonard (Jun. '40), Eng. Apprentice, M. of W. Dept., P.R.R., 402 West College, Greenville, Ill.

Relf, Josiah Frank (Assoc. M.'40), Associate Agri. Engr., SCS, U.S. Dept. of Agriculture, Poteau, Okla.

Richardson, Ford, Jr. (Jun. '40), Chainman Consolidation Coal Co., Watson Bldg. (Res. 519 Gaston Ave.), Fairmont, W.Va.

Rieben, Thorburn Rees (Jun. '40), Draftsman, Pacific Ry. Equipment Co., 5700 Eastern, Los Angeles, Calif.

Roats, George (Jun. '40), Chainman, N.P.Ry., Tacoma (Res., Richmond Beach), Wash.

Roberson, Cecil Thomas (Jun. '40), Junior Ordnance Insp., War Dept., Post Office Bldg., Pittsburgh, Pa. (Res., Mays Lick, Ky.)

Rogers, Eldon Alkire (Jun. '40), Care, Caddo County Health Unit, 325 West Broadway, Anadarko, Okla.

Rolly, George Philip (Jun. '40), Junior Civ. Engr., Francisco & Jacobus, 511 Fifth Ave., New York (Res., 424 Beach 129th St., Rockaway Beach), N.Y.

Samuelson, Hyman (Jun. '40), 3938 Delachaise St., New Orleans, La.

Sandlin, Fred Cole (Jun. '40), Rodman, State Highway Dept., Voth Rd., Beaumont, Tex.

Scarbrough, Ben Allen (Jun. '40), Junior Civ. Engr., U.S. Forest Service, Oxford, Miss. (Res., 2532 Seventeenth St., Ensley, Birmingham, Ala.)

Schake, Elmer Edward (Jun. '40), Asst. Engr., City of Davenport, City Hall (Res., 2035 West 1st St.), Davenport, Iowa.

Schwersenz, Gerard (Jun. '40), Eng. Foreman, Automatic Steam Products Co., 2[illegible] West 25th (Res., 255 West 101st St.), New York, N.Y.

Scrivner, James Daniel (Jun. '40), Instrumentman, State Highway Board, Cleveland, Ga.

Shaver, John Watson (Jun. '40), Traffic Eng. Aid, Traffic Dept., Div. VII, State Highway Dept., 313 Second and Spring St. Bldg. (Res., 2553 Mallory St.), Los Angeles, Calif.

Sheahan, Edmund Corbett (Jun. '40), 47 Prospect St., Somersworth, N.H.

Shepard, Robert Easton (Jun. '40), Eng. Aide, U.S. Engr. Dept., Mud Mountain Dam, Enumclaw, Wash.

SHILLING, MERLE MATHIAS (Jun. '40), Eng. Draftsman, Design Dept., State Highway Comm., Masonic Temple (Res., 1043 College Ave.), Topeka, Kans.

SKABIE, ALLAN MARVIN (Jun. '40), 10475 Kinnard Ave., Los Angeles, Calif.

SKOWRONEK, LESTER JOHN (Jun. '40), 353 Massachusetts Ave., Cambridge, Mass.

SLAIGHT, FRANK DOVELL (Jun. '40), With Fabricated Steel Constr. Div., Bethlehem Steel Co., 8301 South Stewart Ave. (Res., 6545 South Union Ave.), Chicago, Ill.

SMITH, DARCEL CALL (Jun. '40), Chainman, State Dept. of Public Works, Bureau of Highways, Box 789, Pocatello, Idaho.

SMITH, DAVID BARRY (Jun. '40), Instr., Alabama Polytechnic Inst., 417 Sanford Ave., Auburn, Ala.

SMITH, WAYNE WINTER (Jun. '40), Illinois Inst. of Technology, 3254 South Michigan, Chicago, Ill.

SODANO, WALTER HORACE (Jun. '40), Draftsman, Fore River Shipbuilding Plant, Bethlehem Steel Corp., Quincy (Res., 64 Endicott St., Canton), Mass.

SONNICHSEN, JOHN CHRISTIAN (Jun. '40), Bridge Draftsman, Bridge Dept., State Highway Dept. (Res., 109 West 18th St.), Olympia, Wash.

SPAULDING, JOHN NORMAN (Assoc. M. '40), Asst. Engr., Pacific Gas & Elec. Co., 245 Market St., San Francisco, Calif.

STANDER, RICHARD RAMSAY (Jun. '40), Engr., Mansfield Asphalt Paving Co., Rear 31 East Orange St., Mansfield, Ohio.

STEARNS, DONALD ELMER (Assoc. M. '40), Asst. Prof., Civ. Eng., Rhode Island State College, Kingston, R.I.

STEIN, LEON (Jun. '40), 726 North Breed St., Los Angeles, Calif.

STEINER, VERNON FREDERICK (Jun. '40), Draftsman, Am. Bridge Co. (Res., 933 Latimer Ave.), Ambridge, Pa.

STONE, WILLIAM LIVINGTON, JR. (Jun. '40), Rodman, Caye Const. Co., Inc., 356 Fulton St. (Res., 473 Bay Ridge Parkway), Brooklyn, N.Y.

SWARTWOUT, WILLIAM HENRY, JR. (Assoc. M. '40), With New York City Tunnel Authority, 200 Madison Ave., New York (Res., 19 Maple St., Brooklyn), N.Y.

SWATOSH, WENDELL ROBERT (M. '40), Asst. Engr., Erie R.R., 700 Midland Bldg., Cleveland, Ohio.

SWEET, JAMES SIMEON (Assoc. M. '40), Acting Hydrologic Supervisor, U.S. Weather Bureau, Albany (Res., 22 Stratton Pl., Delmar), N.Y.

TAHER, MAHMOOD KHAN (Assoc. M. '40), With Albert Kahn, Associated Archts. and Engrs., Inc., New Center Bldg. (Res., 69 West Bethune), Detroit, Mich.

TAKAYAMA, SHIGEO JULIUS (Jun. '40), Surv., J. B. Haddock, Ltd., 3578 East Foothill Blvd. (Res., 310 West Green St.), Pasadena, Calif.

TEMPLETON, ALEXANDER SHANNON (Assoc. M. '40), Constr. Engr., E. I. du Pont de Nemours & Co., Tennessee Powder Co., Millington (Res., 2515 Yale St., Memphis), Tenn.

THIEBAUD, MEDILL PIERRE (Assoc. M. '40), With State Div. of Water Resources, State Public Works Bldg. (Res., 4339 Broadway), Sacramento, Calif.

THIEL, CHARLES JOSEPH (Assoc. M. '40), Court House, Newport (Res., 811 Fifth Ave., Dayton), Ky.

TOGASAKI, MINORU (Jun. '40), 1022 Forest, Ann Arbor, Mich.

TRESLER, GEORGE WILSON, JR. (Jun. '40), Detailer, Am. Bridge Co. (Res., 434 Taft St.), Gary, Ind.

TUSSING, JOHN ALEXANDER (Assoc. M. '40), Structural Engr., Baltimore Steel Co., 1400 Eastern Ave., Baltimore (Res., 58 Mellor Ave., Catonsville), Md.

VAN BUSKIRK, PAUL (M. '40), Engr., Port of Detroit Comm., 3902 Barlum Tower (Res., 1524 Clairmount Ave.), Detroit, Mich.

VAUGHT, GEORGE WILLITS (Jun. '40), 737 East Cypress, Burbank, Calif.

VINER, ROBERT VICTOR (Jun. '40), 707 Kentucky Ave., S.E., Washington, D.C.

WAINWRIGHT, CY HAYDEN (Assoc. M. '40), Technical Foreman Engr., U.S. Grazing Service, CCC, G-121, Cherry Creek, Nev.

WALDENMAIER, BERNHARDT ALBERT (M. '40), State Field Engr., Federal Works Agency, WPA, Caswell Bldg., Raleigh (Res., 720 Hay St., Fayetteville), N.C.

WARDER, MARSHALL HOWELL (Jun. '40), Civ. Engr., Lockwood & Green Engrs., Inc., Camp Shelby (Res., 868 Main St., Hattiesburg), Miss.

WARNER, MARVIN ELLSWORTH (Jun. '40), Draftsman and Res. Insp., Roberts and Schaeffer Co., 2017 S St., N.W., Washington, D.C.

WASHBURN, WALTER WEBSTER (M. '40), Chf. Engr., Southwestern Constr. Co., 3802 Calhoun Ave. (Res., 2128 West Main St.), Houston, Tex.

WATSON, ARTHUR REID (Jun. '40), With Holly Sugar Corp., Hamilton City, Calif.

WAXMAN, DAVID (M. '40), Mgr., Asphalt Sales, Shell Oil Co., Inc., 50 West 50th St., New York, N.Y.

WEAVER, RALPH EARL (Jun. '40), Office Mgr., Universal Concrete Pipe Co., Inc., Box 92 (Res., 46 Trafalgar St.), Rochester, N.Y.

WEEKS, WILLIAM ALFRED (Assoc. M. '40), Eng. Insp., Grade 4, Board of Water Supply, 346 Broadway, New York (Res., 6706 Sixty-Fourth St., Ridgewood), N.Y.

WEITZ, SAUL (Jun. '40), 3121 Mount Pleasant St., Washington, D.C.

WENK, EDWARD, JR. (Jun. '40), Architectural Designer, 2260 Brookfield Ave., Baltimore, Md. (Res., 12 Sumner Rd., Cambridge, Mass.)

WIENSENFELD, JOEL (Jun. '40), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

WIITALA, SULO WERNER (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, 511 Board of Trade Bldg., Indianapolis, Ind.

WILEY, JOHN EDWARD (Assoc. M. '40), Engr.-Secy., Associated Gen. Contrs. of Wyoming; (Quinn-Wiley Co.) Plains Hotel (Res., 3419 Warren Ave.), Cheyenne, Wyo.

WILLIAMSON, JOE, JR. (Assoc. M. '40), Vice-Pres. in Chg., Florida Office, Russell & Axon, 4903 Delmar Blvd., St. Louis, Mo. (Res., 413 South Palmetto Ave., Daytona Beach, Fla.)

WILSON, JOHN GIBSON, JR. (Jun. '40), Estimator, Keller Concrete Constr., 1108 Sixteenth St., N.W., Room 301 (Res., 5830 Southern Ave., S.E.), Washington, D.C.

WRIGHT, HOLLIS GARRETT (Jun. '40), Asst. Engr., Dravo Corp., Neville Island, Pittsburgh, Pa.

ZAHID, FUAD AHMED (Jun. '40), 432 Thompson St., Ann Arbor, Mich.

ZICK, LEONARD PAUL, JR. (Jun. '40), 3254 South Michigan, Chicago, Ill.

MEMBERSHIP TRANSFERS

BESOZZI, LEO (Assoc. M. '36; M. '40), Cons. Engr., 314 Hammond Bldg., Hammond, Ind.

BULLOCK, CARLOS DEWITT (Jun. '35; Assoc. M. '40), Engr., Federal Works Agency, PWA, City Hall, Vinita, Okla.

CAMPBELL, FRANK BIXBY (Jun. '28; Assoc. M. '37; M. '40), Associate Engr., U.S. Engr. Office, Nashville, Tenn.

CANTINE, THOMAS ROBINSON (Jun. '32; Assoc. M. '40), Asst. Engr., Corps of Engrs., U.S. Army, 628 Pittock Block, Portland, Ore.

CAPLING, LEONARD (Jun. '33; Assoc. M. '40), 6909 One Hundred and Eighth St., Forest Hills, N.Y.

COWEN, CHESTER MELCENIA (Jun. '31; Assoc. M. '40), Gen. Contr., 321 Iowa Ave., Chickasha, Okla.

CSANYI, LADIS HENRY (Assoc. M. '35; M. '40), Asst. Engr., Supt., Municipal Asphalt Plants, Dept. of Borough Works of Manhattan, 501 East 90th St., New York (Res., 86-45 Chelsea St., Jamaica), N.Y.

DWYRE, BURTON GOLDING (Jun. '24; Assoc. M. '30; M. '40), State Highway Engr., State Highway Dept. (Res., 415 Canyon Rd.), Santa Fe, N.Mex.

EARNEST, GEORGE BROOKS (Assoc. M. '35; M. '40), Asst. Prof., Civ. Eng., Case School of Applied Science, University Circle, Cleveland, Ohio.

FINCK, HERBERT FERDINAND (Assoc. M. '25; M. '40), Power, Civ. and Hydr. Engr., Ecusta Paper Corp., Pisgah Forest (Res., Main St., Brevard), N.C.

FISCHER, PHILIP CONRAD (Jun. '37; Assoc. M. '40), Transitman, Dept. of Water Supply, Gas and Electricity, Room 2449 Municipal Bldg., New York, N.Y.

FLINT, RAYMOND EUGENE (Jun. '35; Assoc. M. '40), Field and Office Engr., Frazier-Davis Constr. Co., 1319 Macklind Ave., St. Louis, Mo. (Res., 14 Sycamore Rd., Mahopac, N.Y.)

FRASER, ROBERT HAMILTON (Jun. '38; Assoc. M. '40), Estimator, Chemical Constr. Corp., 30 Rockefeller Plaza (Res., 241 East 52d St.), New York, N.Y.

GAINES, FRANK PENDLETON (Jun. '29; Assoc. M. '40), Associate Engr., U.S. Engrs. (Res., 2502 West Ashwood Ave.), Nashville, Tenn.

GARDNER, ROBERT ANTHONY (Jun. '33; Assoc. M. '40), Hydr. Engr., Bureau of Encroachments, State Dept. of Forests and Waters, Education Bldg. (Res., 3246 Green St.), Harrisburg, Pa.

GLAZBROOK CHARLES STUART (Assoc. M. '23; M. '40), Engr., Met. Water Dist. of Southern California, 306 West 3d (Res., 3017 La Paz Drive), Los Angeles, Calif.

HARTIG, FRANZ JOHN (Jun. '29; Assoc. M. '40), Senior Eng. Aide, Service Div., Chemical Warfare Service, War Dept., Edgewood Arsenal, Edgewood (Res., 3730 Winterbourne Rd., Baltimore), Md.

HERTEL, RAYMOND ERNEST (Jun. '30; Assoc. M. '40), Associate Highway Engr., Public Roads Administration, South Chicago Post Office Bldg., Chicago, Ill.

HUEBNER, JOHN BRADY (Jun. '31; Assoc. M. '40), Asst. Engr., U.S. Engr. Dept., Gay Bldg., Little Rock, Ark.

IVY, RAYMOND JENNINGS (Jun. '37; Assoc. M. '40), Asst. Bridge Engr., State Div. of Highways, Box 1499 (Res., 1833 Third Ave.), Sacramento, Calif.

JONES, RALPH WESLEY (Assoc. M. '28; M. '40), Consultant, 429 East Phil Ellena St., Philadelphia, Pa.

MITCHELL, ADOLPHUS (Jun. '31; Assoc. M. '30), Senior Traffic Engr., State Highway and Public Works Comm., Raleigh, N.C.

MURPHY, RAYMOND WILLIS (Assoc. M. '31; M. 40), Engr., U.S. Indian Service, 215 Treasure State Bldg., Billings, Mont.

NAUMAN, ARTHUR CHARLES (Jun. '34; Assoc. M. '40), Quartermaster, CCC, Headquarters, 6th Corps Area, War Dept., 20 North Wacker Drive (Res., 2629 Greenleaf Ave.), Chicago, Ill.

PINYAN, RONALD AUGUST (Jun. '32; Assoc. M. '40), Engr., Ford J. Twaites Co., Architects Bldg. (Res., 415 South Burlington Ave.), Los Angeles, Calif.

POLI, THOMAS (Jun. '31; Assoc. M. '40), Topographical Section Head, Dept. of Hospitals, City of New York, 125 Worth St., New York (Res., 673 Fifty-Ninth St., Brooklyn), N.Y.

SANTACRUZ, ARMANDO, JR. (Jun. '24; Assoc. M. '31; M. '40), Director, Technical Control, Federal Dept. of Communications and Public Works (Res., Cerrado Amores 24, Colonia del Valle), Mexico, D.F., Mexico.

SCHROEDER, CHARLES WILLIAM EMIL (Jun. '28; Assoc. M. '40), Asst. Civ. Engr., Transit Comm., 270 Madison Ave., New York (Res., 3143 Eighty-Fifth St., Jackson Heights), N.Y.

SCHULTZ, ERNEST RICHARD (Jun. '30; Assoc. M. '40), Capt., Quartermaster Reserve Corps, U.S. Army, Fort F. E. Warren, Cheyenne, Wyo.

SCHWEGLER, RAMON MILES (Jun. '29; Assoc. M. '40), Materials Engr., Public Roads Administration, Box 3900 (Res., 3800 North East 78th Ave.), Portland, Ore.

SIEKIELSKI, GEORGE STANLEY (Jun. '31; Assoc. M. '40), Erosion Engr., TVA, Forestry Bldg., Norris, Tenn.

SOMMA, GEORGE EDWARD (Jun. '31; Assoc. M. '40), Structural Designer, Madigan-Hyland, 28-04 Forty-First Ave., Long Island City (Res., 28 Rathburn Ave., White Plains), N.Y.

STANDLEY, DAVID (Jun. '23; Assoc. M. '30; M. '40), Mgr., Manhattan Dist. Office, WPA, 70 Columbus Ave., New York (Res., 1464 East 10th St., Brooklyn), N.Y.

STANLEY, CLAUDE MAXWELL, JR. (Jun. '26; Assoc. M. '37; M. '40), Cons. Engr. (Stanley Eng. Co.), 301 Iowa Ave., Muscatine, Iowa.

TRAVIS, WAYNE IVAN (Jun. '34; Assoc. M. '40), Associate Engr., U.S. Geological Survey, 508 Hydraulics Laboratory, Iowa City, Iowa.

UITTI, WILLIAM LEOPOLD (Jun. '34; Assoc. M. '40), Structural Steel Insp., Chicago Rapid Transit Co., 72 West Adams St. (Res., 4516 North Lawndale Ave.), Chicago, Ill.

WALLENIUS, JOHN WILLIAM (Jun. '28; Assoc. M. '40), Supervisor, P.R.R., Room 202 Pennsylvania Station (Res., 3650 Ellerslie Ave.), Baltimore, Md.

WELLS, WILLIAM LEONIDAS (Jun. '37; Assoc. M. '40), Chf., Soil Mechanics Laboratory, U.S. Waterways Experiment Station, Vicksburg, Miss.

WHITE, EDWARD EMELIN (Jun. '34; Assoc. M. '40), With Spencer, White & Prentis, Inc., Portsmouth (Res., 1330 Willow Wood Drive, Norfolk), Va.

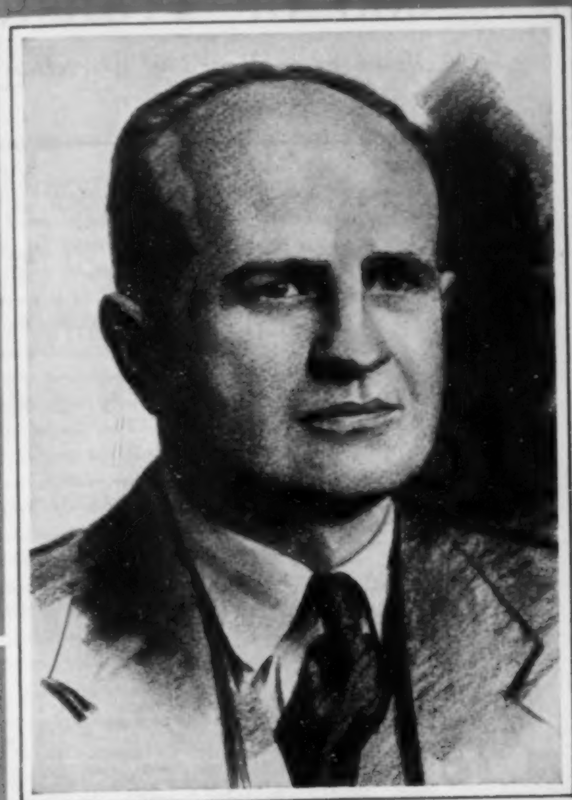
REINSTATEMENTS

GORMAN, FRANK LEE, M., reinstated Nov. 12, 1940.

RESIGNATIONS

ROLLINS, LEIGHTON BOND, Jun., resigned Dec. 1, 1940.

J. C. LINDSEY



Water Operations Supt., Seattle Water Dept.

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CAST IRON PIPE

PUBLIC TAX SAVER NO. 1

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

January 1, 1941 — NUMBER 1

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

AMSBARY, FRANK CLIFFORD, JR., Champaign, Ill. (Age 40) (Claims RCA 8.0 RCM 9.5) 1923 to date with Champaign-Urbana Water Co., as Superv. Engr., Local Mgr., Director, and Secy.

BLOMGREN, B. EDWIN, Kalamazoo, Mich. (Age 51) (Claims RCA 2.1 RCM 19.3) July 1933 to date with Michigan State Highway Dept. as Maintenance Engr., and (since Oct. 1938) Dist. Engr.

CLARKE, HAROLD, Los Angeles, Calif. (Age 40) (Claims RCA 3.3 RCM 9.4) Aug. 1935 to Dec. 1938 Asst. Engr., and Dec. 1938 to date Associate Engr., U.S. Engr. Dept.

CLAYBAUGH, KELLEY WAYNE, Arkansas City, Kans. (Age 40) (Claims RCA 4.3 RCM 7.5) May 1921 to date with Atchison, Topeka & Santa Fe Ry., as Rodman, Transitman, Asst. Engr., Draftsman, Office Engr., Roadmaster, and (since July 1939) Div. Engr.

DEJARNETTE, WILLIAM POU, JR., Alexander City, Ala. (Age 36) (Claims RCA 4.4 RCM 11.1) Sept. 1932 to date with Alabama Highway Dept., as Res. Engr., Asst. Div. Engr., and (since March 1939) Div. Engr., 4th Div.

FOLEY, JOSEPH FRANCIS, Somerset, Mass. (Age 51) (Claims RC 26.5 D 16.0) Jan. 1925 to date with Callan Constr. Co., Inc., Bristol, R.I., acting as Chf. Engr.; also at present acting as Chf. Engr. for four other companies, and Chf. Engr. and Treas., Joseph F. Foley Eng. Co.

FOWLER, WILLIAM BINGHAM, Memphis, Tenn. (Age 54) (Claims RCA 6.7 RCM 21.7) Sept. 1918 to date with City of Memphis, Tenn., as Asst. City Engr., and (since May 1919) City Engr.

GRAEF, RICHARD FRANCIS, Baltimore, Md. (Age 37) (Claims RCA 4.2 RCM 9.6) Feb. 1928 to April 1929 Designer and, Aug. 1940 to date, Project Engr., Whitman, Requardt & Smith; in the interim Bridge Engr., Pennsylvania Turnpike Comm.; Structural Engr., H. K. Ferguson Co.; Bridge Designer, Bridge Div., Pennsylvania Dept. of Highways; Civ. Engr., Bureau of Water, Reading, Pa.

GRAMSTORFF, EMIL ANTON (Assoc. M.), Boston, Mass. (Age 48) (Claims RCA 5.6 RMC 14.3) Sept. 1921 to date with Coll. of Eng., Northeastern Univ., as Instructor, Asst. Prof., Associate Prof., and (since May 1939) Prof. of Civ. Eng., and Chairman of Dept.

GUERIN, GEORGE VINCENT, JR. (Assoc. M.), St. Paul, Minn. (Age 38) (Claims RCA 7.8 RCM 5.6) June 1924 to date with Great Northern Ry., as Draftsman, Inspector, Asst. Bridge Engr., and (since Jan. 1940) Bridge Engr.

HARGER, KENDRICK, Chicago, Ill. (Age 53) (Claims RCA 12.7 RCM 15.5) Sept. 1921 to date Jun. Highway Engr., Asst. Engr., Dist. Engr. of County Roads, and (since March 1933) Dist. Engr., Dist. No. 10 (Cook County), State of Illinois, Div. of Highways.

HARVIE, WILLIAM HENRY, East Lansing, Mich. (Age 41) (Claims RCM 16.5) July 1933 to date with Michigan State Highway Dept., as Asst. Dist. Engr., Dist. Engr., and (since July 1937) Road Engr.

HENDON, HARRY HOLMAN (Assoc. M.), Birmingham, Ala. (Age 36) (Claims RCA 4.0 RCM 8.7) 1925 to 1936 and 1938 to date with Jefferson County, Ala., as Transitman, Asst. Engr., San. Engr., and (since 1938) Chf. Engr.; in the interim Res. Engr., Birmingham Industrial Water Supply.

JACKSON, RUEL REAGAN, Washington, D.C. (Age 51) (Claims RCM 27.2) July 1938 to date with WPA, until Feb. 1940 in Illinois as Gen. Supt., and (since Feb. 1940) in Washington, D.C., as Asst. Director, Bldg. Sec., Eng. Div.; previously Gen. Supt., Illinois Armory Board, Chicago, Ill.; previously general contractor.

JONES, JOSEPH WILLIAM (Assoc. M.), Towson, Md. (Age 44) (Claims RCA 8.1 RCM 9.5) May 1922 to date with Baltimore & Ohio R.R., as Inspector-Transitman, Field Engr., and (since Oct. 1935) Res. Engr.

LANE, JOHN ELLISON, Brooklyn, N.Y. (Age 41) (Claims RCM 20.0) March 1940 to date in private practice as Surlaz Development Corporation; previously with Bureau of Rehabilitation, Insurance Dept., State of New York, as Property Rehabilitation Supervisor.

LINDGREN, RAY HARRISON, Cambridge, Mass. (Age 46) (Claims RCA 5.5 RCM 15.9) Feb. 1918 to April 1935 with The Crandall Eng. Co., and April 1935 to date Treasurer and Engr., Crandall Dry Dock Engrs., Inc.

MCMATH, NEIL COOK, Detroit, Mich. (Age 48) (Claims RCA 9.5 RCM 7.0) March 1926 to date with Whitehead & Kales Co., Structural Steel Fabricators and Engrs., since 1934 Vice-Pres.

RABUCK, ARTHUR JACOB (Assoc. M.), Milwaukee, Wis. (Age 49) (Claims RCA 3.5 RCM 13.8) Jan. 1933 to date Planning and Zoning Consultant for many municipalities.

RIVIERE, JAMES ANDREW (Assoc. M.), Tallahassee, Fla. (Age 36) (Claims RCM 10.8) March 1930 to date with Florida State Road Dept., as Project Engr., Div. Engr., and (since Sept. 1937) Div. Engr. of Plans & Surveys.

SMITH, LAWRENCE TALMA, Chicago, Ill. (Age 43) (Claims RCA 6.3 RCM 11.9) Jan. 1935 to date Superv. Structural Designer and Res. Constr. Engr., Chicago (Ill.) Park Dist., Eng. Div.; Capt., Engr.-Reserve, U.S. Army.

STIMPSON, CLARENCE AMOS (Assoc. M.), Ann Arbor, Mich. (Age 56) (Claims RCA 10.8 RCM 5.9) Oct. 1926 to date Senior Engr., Jensen, Bowen & Farrell.

STUCK, RAYMOND WILBER, East Orange, N.J. (Age 53) (Claims RCM 21.2) May 1934 to date with Corps of Engrs., U.S. Army as Associate Engr., Engr., and (since Aug. 1936) Senior Engr. and (at present) Prin. Engr.

WANAMAKER, WILLIAM WESLEY, Little Rock, Ark. (Age 42) (Claims RCA 6.9 RCM 12.1) Sept. 1921 to date with U.S. Army, Corps of Engrs., as 2d Lieut., 1st Lieut., Capt., and at present Major, in various capacities, since Aug. 1940 Asst. to U.S. Div. Engr., Southwestern Div.

WILLIAMS, NORMAN FERDINAND (Assoc. M.), Chattanooga, Tenn. (Age 41) (Claims RCA 3.5 RCM 10.8) April 1924 to Feb. 1929 and Sept. 1931 to date with The Tennessee Elec. Power Co. (in liquidation), as Asst. Engr., Chf. Engr., and (since Aug. 1939) Mgr. of Transporation and Vice-Pres., also Vice-Pres., Nashville Coach Co.

APPLYING FOR ASSOCIATE MEMBER

BAIRD, CHARLES OSCAR, JR., Boston, Mass. (Age 39) (Claims RCA 8.3) 1922 to date at Northeastern Univ., as Instructor, and (since 1932) Asst. Prof. of Civ. Eng.

BANKS, HARVEY OREN (Junior), Los Angeles, Calif. (Age 30) (Claims RCA 3.4) Feb. 1938 to date Asst. Hydr. Engr., California Div. of Water Resources; previously Hydr. Engr., Design Engr., Office Engr., and Asst. Project Engr., U.S. SCS, Watsonville, Calif.

BENASSINI VIZCAINO, AURELIO, Mexico, D.F., Mexico. (Age 33) (Claims RCA 2.0 RCM 4.0) Dec. 1932 to date with National Comm. of Irrigation as Engr. D, Head of Oficinia de Planeacion, and (since Jan. 1937) Head of Dept. of Studies.

BLAIN, WILBER ALEXANDER (Junior), Galveston, Tex. (Age 32) (Claims RCA 4.3) Dec. 1933 to date with U.S. Engr. Dept., as Inspector, and (since April 1937) Jun. Engr.

BRADLEY, CHARLES SMITH (Junior), Brawley, Calif. (Age 28) (Claims RCA 4.0) Dec. 1935 to Sept. 1938 with Morrison-Utah-Winston, and Oct. 1934 to Dec. 1935 and Sept. 1938 to date with Morrison-Knudsen Co., Inc., as Field Engr., etc., and Chf. Job Engr.

BROWN, RUSSELL MERRITT, Lemoyne, Pa. (Age 44) (Claims RCA 17.9) Oct. 1940 to date Structural Designer, Whitman, Requardt & Smith; previously Bridge Designer, Pennsylvania Turnpike Comm.; Detailer, Designer and Asst. Engr. of Bridge Design, Bridge Dept., Indiana Highway Comm., Indianapolis.

BURGESS, RALPH NORMAN, Tucson, Ariz. (Age 52) (Claims RC 5.9) July 1935 to date Engr. (private practice) on ranch, subdivision and lot surveys, also architectural work on small houses.

CASSEDY, THOMAS SPENCER, Middle River, Md. (Age 36) (Claims RCA 11.0 RCM 1.8) Sept. 1940 to date Civ. Engr., Whitman, Requardt & Smith; previously Civ. Engr., Glenn L. Martin Co. & Stansbury Manor, Inc., Associate Engr. and Associate San. Engr. for Greenbelt (Md.) Housing Project, etc.; Asst. Engr., Res. Engr. and Civ. Engr., Barker & Wheeler, Engrs.

COX, JOHN JOSEPH (Junior), Jackson Heights, N.Y. (Age 32) (Claims RCA 5.2) April 1939 to date with Dept. of Public Works, New York City; previously Jun. Engr. Inspector, PWA; with Dept. of Water Supply; Chf. of Party, successively with Borough Pres. of Bronx, and Dept. of Parks, New York City.

CREASY, DONALD CRAMPTON (Junior), New York City. (Age 30) (Claims RCA 9.0) Nov. 1932 to date Constr. and Maintenance Engr., The Beekman Estate.

CROCKETT, EDWARD ST. LAWRENCE, Morristown, Tenn. (Age 41) (Claims RCA 15.6) April 1935 to date with TVA, as Prin. Eng. Aide, Chf. Eng. Aide, Asst. Field Engr., and (since Aug. 1940) Associate Field Engr.

DODDS, ARTHUR EARNEST WILLIAM (Junior), Portland, Ore. (Age 32) (Claims RCA 3.6) Sept. 1938 to date with Bonneville Power Administration as Asst. Structural Engr., and (since Nov. 1940) Associate Engr. (Structural); previously Bridge Designer, Washington State Bridge Dept.; Jun. Engr., U.S. Bureau of Reclamation; Structural Designer and Detailer for James Taylor, Jr., Archt., and S. Ivarsson, Structural Engr., both of Seattle, Wash.

EISENLOHR, WILLIAM STEWART, JR. (Junior), Arlington, Va. (Age 33) (Claims RCA 4.8) June 1928 to date with U.S. Geological Survey as Jun. Engr., Asst. Engr., and (since March 1939) Asst. and Associate Engr.

ELLIOTT, EMRIC ALEXANDER, Scottsboro, Ala. (Age 33) (Claims RCA 2.4) 1938 to date Engr., Cities of Falkville and Hartselle, Ala., since Nov. 1940 also County Engr., Jackson County Court of Comm., previously Engr., Alabama Power Company; Engr. and Chf. of Party, Pacific Power and Light Co.

ERWIN, CYRAL PHILPOTT, Oklahoma City, Okla. (Age 31) (Claims RCA 3.7 RCM 0.8) July 1940 to date Managing Engr., Star Mfg. Co.; previously Designing Engr. with A. M. Brenneke, Cons. Engr. for City of Denison, Tex.; private surveying work; previously County Engr., San Augustine and Sabine Counties, and City Engr., San Augustine.

FLINSCH, HAROLD VON NEUFVILLE (Junior), Lewisburg, Pa. (Age 32) (Claims RCA 4.5) July 1940 to date Asst. Prof. of Civ. Eng., Bucknell Univ.; previously at Univ. of Minnesota as Research Asst., and Associate Physicist.

FORREST, ROBERT, Troy, N.Y. (Age 32) (Claims RCA 5.0) March 1940 to date Asst. Engr., Board of Hudson River Regulating Dist., Albany, N.Y.; previously Asst. Engr., Rensselaer County Highway Dept., Res. Engr., Hadley (N.Y.) Sewer Dist.; Jun. Lighthouse Engr., U.S. Dept. of Commerce, Lighthouse Service, Buffalo, N.Y.; with City of Troy, N.Y., as Engr., Technician, and Purchasing Agt.

GALLEN, JOHN JAMES, Philadelphia, Pa. (Age 35) (Claims RCA 4.4) Sept. 1940 to date Instructor in Civ. Eng., Villanova (Pa.) Coll.; previously Diocesan Supt. of Schools, Philadelphia, Pa.; Senior Engr., WPA road project, Schwenksville, Pa.

GIHRING, ARNOLD FRANK, St. Louis, Mo. (Age 32) (Claims RCA 1.5) July 1935 to date with U.S. Div. Engr. Office, War Dept., as Jun. Engr., and (since July 1938) Asst. Engr.

GODWIN, MERLE HAUN, Sacramento, Calif. (Age 43) (Claims RCA 7.7) Jan. 1928 to date with California Div. of Highways as Asst. Res. Engr., Jun. Designing Engr. of Bridges, and (since Feb. 1933) Associate Bridge Engr.

HARBIN, SAMUEL WALTON, Montgomery, Ala. (Age 41) (Claims RCA 6.2 RCM 7.4) July 1924 to date with Alabama Highway Dept., as Rodman, Draftsman, Paving Inspector, Field Draftsman, Chf. of Party, Res. Engr., Chf. Draftsman, and (since Jan. 1939) Engr. of Surveys & Plans.

HAWKINS, HAROLD VERN (Junior), Ithaca, N.Y. (Age 28) (Claims RCA 1.0) Sept. 1936 to date with Dept. of Civ. Eng., Cornell Univ., as Instructor, and (since Sept. 1940) Asst. Prof.

HOLOBER, DAVID GEORGE (Junior), Brooklyn, N.Y. (Age 28) (Claims RCA 5.1) Feb. 1940 to date Project Mgr., Neff Lathing Co., New York City; previously Engr. and Estimator, James Stewart & Co., New York City; Asst. Engr., Borough Pres. of Bronx, Highway Dept.

HORNE, ROBERT CHARLES, Silver Spring, Md. (Age 31) (Claims RCA 5.3 RCM 4.0) Feb. 1935 to date with National Park Service as Jun. Civ. Engr., Chf., Res. Engr., and (since Dec. 1939) Associate Engr.-Chf., Eng. and Constr. Sec., Planning and Constr. Div., and Res. Engr.

HOUGH, LAWRENCE EVERT, Fairbanks, Alaska. (Age 34) (Claims RCA 1.3 RCM 1.8) Sept. 1938 to date Instructor in Civ. Eng. and Mathematics, Univ. of Alaska; summers 1939 and 1940 successively with Stewart & Reed Engrs., City of Fairbanks; previously in private practice as Surveyor and Engr.; City Engr., Ketchikan, Alaska; Field Engr., Stratton & Beers, Engrs., Juneau, Alaska.

JERVIS, WILLIAM HORACE (Junior), Vicksburg, Miss. (Age 32) (Claims RCA 1.1 RCM 5.4) July 1929 to date with U.S. Engr. Office as Instrumentman, Asst. Foreman, Night Foreman, Levee Inspector, Office Asst., Senior Inspector, Asst. to Chf., and (since Nov. 1933) Chf., Soils Sec.

KOTECKI, HARRY ALOYSIUS, Parker Dam, Calif. (Age 32) (Claims RC 1.6 D 1.0) 1940 B.S. in Civ. Eng., Univ. of Ariz.; Summer 1939 Designer and June 1940 to date Chf. of Survey Party, Parker Dam project; previously with U.S. Bureau of Mines, Arizona Highway Dept., and U.S. Coast & Geodetic Survey.

KUNSCH, HAROLD EDWARD, Baltimore, Md. (Age 35) (Claims RCA 9.0 RCM 3.3) Aug. 1940 to date Senior Structural Designer, Whitman, Requardt & Smith, Engrs.; previously Bridge Designer, Bridge Div., Pennsylvania Turnpike Comm., Harrisburg, Pa.; Eng. Draftsman, Wright Mfg. Div., American Chain & Cable Co., Inc., York, Pa.; Senior Draftsman to Jun. Designer, Bridge Unit, Pennsylvania Dept. of Highways, Harrisburg, Pa.

LAZENBY, ARTHUR J. (Junior), Salt Lake City, Utah. (Age 32) (Claims RCA 3.0 RCM 3.3) Aug. 1933 to date with Salt Lake City Water Dept., as Asst. San. Engr., Engr., and Asst. Engr. in charge of ground-water investigations.

MACFARLAND, LESTER BURTON (Junior), Wollaston, Mass. (Age 32) (Claims RCA 3.7 RCM 3.4) May 1934 to date Asst. Civ. Engr., U.S. Dept. of Agriculture, Forest Service, Boston, Mass.

MACILVAINE, MEREDITH KIDD, Highland Park, Mich. (Age 43) (Claims RCA 22.9) May 1938 to date Area Engr., WPA, Dist. No. 4, Detroit and Metropolitan areas of Wayne County, Mich.; previously Gen. Supt. with Ray Sablain, Gen. Contr., Lansing, Mich.

MCCOY, JOHN DAVID, Conchas Dam, N.Mex. (Age 33) (Claims RCA 2.1) Nov. 1938 to date with U.S. Bureau of Reclamation, Tucumcari (N.Mex.) Project, as Transitman, Instrumentman, and (since March 1940) Asst. Engr.

MCLAUGHLIN, WILLIAM COLEMAN, Vallejo, Calif. (Age 35) (Claims RCA 6.8) June 1939 to date Senior Inspector of Constr., U.S. Navy, Bureau of Yards and Docks; previously Jun. Mine Engr., Phelp Dodge Corporation; Inspector, U.S. Bureau of Reclamation; Senior Eng. Aide, International Boundary Comm.

MCNEE, THOMAS LEE, Baltimore, Md. (Age 34) (Claims RCA 7.6 RCM 3.8) Aug. 1940 to date with Whitman, Requardt & Smith, Engrs.; previously with Pennsylvania Turnpike Comm.; U.S. Army, and United Engrs. and Constrs., Inc.

MARSHALL, WILLIAM ROBERT, Cleveland, Ohio. (Age 54) (Claims RCA 28.2) Nov. 1918 to date with Erie R.R. Co., as Designer, Asst. Engr. of grade crossings, and (since April 1933) Leading Designer.

MILLEN, VINCENT LADDIE (Junior), Corpus Christi, Tex. (Age 32) (Claims RC 1.8 D 5.0) March 1940 to date Office Engr., Robert & Co., Atlanta, Ga.; previously Salesman, Sales Engr., Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

OLMSTED, ARTHUR GEORGE (Junior), Wadsworth, Ohio. (Age 32) (Claims RCA 3.6 RCM 1.0) April 1937 to date Field Constr. Engr., Pittsburgh Plate Glass Co., Columbia Chemical Div., Barberton, Ohio; previously Field Inspector, The Jennings-Lawrence Co., Columbus Ohio; Asst. Field Engr., WPA, Franklin County, Columbus.

PALMER, FRED ROBERT, Huntington, W.Va. (Age 31) (Claims RCA 0.8 RCM 5.3) June 1934 to date with Sammons-Robertson Co., Contrs., as Chf. Engr., and (since June 1936) Chf. Constr. Engr.

PAPANDREA, NATAL NED (Junior), West Orange, N.J. (Age 32) (Claims RCA 5.3) 1940 to date in private practice, being Res. Engr. and Engr. for various developments, parks, etc.; previously with Freeman & Winston as Asst. Engr., and (later) member of firm; with CWA, ERA, and WPA.

PIERCE, GEORGE NORMAN, Fountain City, Tenn. (Age 29) (Claims RCA 1.6) April 1936 to date with TVA, as Jun. and Asst. Eng. Aide, Jun. Office Engr., and (since Nov. 1938) Jun. and Asst. Hydr. Engr.

POPPER, WILLIAM (Junior), Sacramento, Calif. (Age 32) (Claims RCA 2.2) July 1931 to May 1932 Jun. Bridge Constr. Engr., Jan. to Feb. 1933 and Sept. 1934 to March 1935 Jun. Bridge Designing Engr., and (June 1936 to date) Jun. Bridge Engr., Div. of Highways, State of California; in the interim successively Chf. of Party, Transbay Constr. Co., San Francisco; and Morrison-Utah-Winston (Morrison-Knudsen Co.), Yuma, Ariz.

RIESBOL, HERBERT SPENCER (Junior), Coshocton, Ohio. (Age 32) (Claims RCA 4.4 RCM 0.7) May 1930 to date with U.S. Dept. of Agriculture, as Jun. Civ. Engr., Associate Agri. Engr., Associate Hydr. Engr., and (since May 1940) Hydr. Engr.

RIMMEY, WILLIAM MONROE, Havre de Grace, Md. (Age 31) (Claims RCA 3.4 RCM 1.1) 1936 to 1940 (about 3 years) on PWA work in Maryland; Oct. 1937 to May 1940 (part of time) and May 1940 to date City Engr.

SAHNEY, JAGDISH CHANDRA (Junior), Gonda, U.P., India. (Age 32) (Claims RCA 6.8) April 1936 to date Asst. Engr., Public Works Dept., Bldgs. and Roads Branch, Govt. of United Provinces, India; previously Dist. Engr., Dist. Board, Jhansi.

SAMPSON, ALBERT KENNETH, Santa Monica, Calif. (Age 34) (Claims RCA 5.8) Sept. 1928 to April 1935 and Jan. 1936 to date with Regional Planning Comm., County of Los Angeles, as Jun. Civ. Eng. Draftsman, Asst. Zoning Engr., Zoning Engr., and (since July 1938) Land Use Engr.; in the interim Planning Technician, California State Planning Board.

SEELY, HAROLD TIFFANY, Colorado Springs, Colo. (Age 41) (Claims RCA 7.1 RCM 2.2) May to Dec. 1934 and April 1935 to date with U.S. Dept. of Agriculture, Bureau of Public Roads, and (since Sept. 1935) with SCS as Draftsman, Constr. Engr., and at present Area Engr.

SETTERLIN, RALPH FREDERICK (Junior), Columbus, Ohio. (Age 32) (Claims RCA 2.0 RCM 5.0) Aug. 1935 to date member of firm, Robert W. Setterlin & Son, Gen. Bldg. Contrs.

SHULTZ, ROBERT JOHN (Junior), Los Angeles, Calif. (Age 33) (Claims RCA 2.0) Sept. 1939 to date Jun. Engr., Hydr. Sec., U.S. Engr. Dept.; previously Field Asst., Guy F. Atkinson Co.; Jun. Engr., Civil Aeronautics Authority; Eng. Draftsman, TVA.

SMITH, MILLARD ELTING, Paris, Tenn. (Age 34) (Claims RCA 6.1) Sept. 1940 to date Prin. Eng. Aide, Maps and Surveys Div., TVA; previously Malaria Engr., Alabama State Health Dept.; Asst. Engr., City Engr.'s Office, Bridgeport, Conn.

STUTZ, CLIFFORD NOEL, Bloomington, Ill. (Age 31) (Claims RCA 3.2 RCM 1.5) Sept. 1933 to date Asst. Engr. with J. J. Woltmann, Cons. Engr.

SULKOWSKI, WALTER VALENTINE (Junior), Knoxville, Tenn. (Age 32) (Claims RCA 2.3) Sept. 1935 to date with TVA as Asst. Eng. Draftsman, Eng. Draftsman, and (since Sept. 1938) Jun. Civ. Engr., Constr. Plant Div.

TITUS, HORACE OWEN, Cheyenne, Wyo. (Age 36) (Claims RCA 3.8 RCM 3.5) June 1935 to date with Wyoming State Highway Dept., as Inspector, Instrumentman, and (since Nov. 1935) Draftsman and Bridge Designer.

TUDOR, JARED HENRY, Baltimore, Md. (Age 37) (Claims RCA 8.6 RCM 3.0) Sept. 1940 to date Superv. Designer, Whitman, Requardt & Smith, Engrs.; previously Senior Bridge Designer, Pennsylvania Turnpike Comm., Harrisburg, Pa.; Designer, Gilbert-Varker, Inc.; Designing Engr., Power Piping Corporation, Pittsburgh; with Jones & Laughlin Steel Corporation, and Pennsylvania Dept. of Highways.

WALKER, SAMUEL AUSTIN, JR., South Charleston, W.Va. (Age 29) (Claims RCA 1.5) May 1940 to date Structural Designer, Carbide & Carbon Chemicals Corporation; previously Asst. Designer, Harza Eng. Co., and Form Designer, Central Eng. Co.; Chf. of Party and Asst. Project Engr., Allen & Hoshall, Engrs., Memphis, Tenn.; Structural Designer, Commonwealth & Southern Corporation, Jackson, Mich. Instrumentman, Springfield (Ohio) Conservancy Dist.

WATSON, WILL PAUL, Hamilton, Ohio. (Age 51) (Claims RCA 22.0 RCM 1.8) June 1921 to date Secy.-Treas. and Mgr., The Hamilton (Ohio) Gravel Co.

WILLIAMS, WALTER BELFORD (Junior), Paris, Tex. (Age 30) (Claims RCA 4.1) July 1933 to date with Texas State Highway Dept., as Asphalt Checker, Office Asst., Rodman, Bridge Inspector, Plant Inspector, Office Engr., Asst. Res. Engr., and (since Feb. 1939) Jun. Res. Engr.

YOUNGS, LYMAN GUSTIN (Junior), St. Paul, Minn. (Age 32) (Claims RCA 3.7) March 1934 to March 1939 Jun. Civ. Engr., and April 1939 to date Asst. Highway Engr., Dist. 4, U.S. Bureau of Public Roads (PRA).

APPLYING FOR JUNIOR

BARRISH, JACK SIMON, Sacramento, Calif. (Age 24) (Claims RCA 0.2) 1938 B.S. in Civ. Eng., Univ. of Calif.; June 1938 to date with U.S. Engr. Office, as Axeman, and (since Sept. 1938) Jun. Engr.

DEBERRY, BANNISTER LUTHER, Clarksville, Tex. (Age 26) Aug. 1935 to Sept. 1936 and Aug. 1937 to date with Texas State Highway Dept., as Rodman, Surface Inspector, Instrumentman, and (since Sept. 1939) Field Engr.

FRANCO ALVES, MARCIO de MELLO, Cambridge, Mass. (Age 29) (Claims RC 1.0) 1939 to date Graduate student in civil engineering, Massachusetts Inst. of Technology; previously Engr., City of Rio de Janeiro; member of firm, Marcio & Marcello Llda, Rio de Janeiro, Brazil.

HILTON, WILLIAM LAWRENCE, Roanoke, Va. (Age 26) 1940 B.S. in Civ. Eng., Va. Pol. Inst.; June 1940 to date Engr. and Laborer, Virginia Bridge Co.

LESHER, CARL EUGENE, JR., Harrisburg, Pa. (Age 29) Feb. 1940 to date Asst. Engr., Bureau of San. Eng., Pennsylvania Dept. of Health;

previously Asst. Chemist, Gascoigne and Associates, Cleveland, Ohio; Technician, and Jun. Sales Engr., San. Eng. Div., The Dorr Co., Inc.

LONG, JOHN FREDERICK, Houston, Tex. (Age 30) (Claims RC 3.7) Sept. 1936 to date with U.S. Engr. Dept., 6 months as Asst. Draftsman, then Jun. Engr.; previously 2d Lieut., Field Artillery Reserve; Transitman, WPA, Columbus, Ohio.

SWIFT, WILLIAM OLIVER, JR., Dallas, Tex. (Age 30) (Claims RCA 1.3) 1940 B.S. in C.E. Univ. of Tex.: June 1938 to date with Austin Bros. in various capacities.

WILSON, EDWIN OLIVER, Roswell, N.Mex. (Age 30) (Claims RCA 6.1) Oct. 1940 to date Jun. Civ. Engr. (under Fred C. Scobey) on Pecos River Joint Investigation; previously Jun. Civ. Engr., U.S. Dept. of Agriculture; Jun. Engr., Bureau of Reclamation; Jun. Irrigation Engr. on Rio Grande Joint Investigation; Jun. Civ. Engr. and Chf. of Field Party, U.S. Biological Survey.

1940 GRADUATES

COLUMBIA UNIV. (B.S. in C.E.) — AGE

KEIL, HOWARD WINSTON (26)

STATE UNIV. OF IOWA (B.S. in C.E.)

OLIVER, WARREN JOSEPH (26)

MISS. STATE COLL. (B.S. in C.E.)

LEDBETTER, BEN ARTHUR (22)

UNIV. OF TENN. (B.S. in C.E.)

FULGHUM, GEORGE ALBERT, JR. (25)

UNIV. OF WIS. (B.S.)

NESTINGEN, STANLEY RUDOLPH (25)

UNIV. OF WYO. (B.S. in C.E.)

HENDERSON, MARK HYRUM (21)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Personnel Service, Inc., with offices in Chicago, Detroit, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 132 of the 1940 Year Book of the Society. To expedite publication, notices should be sent direct to the Personnel Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago, Detroit, or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; graduate of Italian university; 12 years experience road and traffic engineering organization; good practice in general civil engineering; at present residing in South America; desires connection with contractors or consulting engineers anywhere in America or East. Also interested in contacting foreign department of U.S. firm. Interested in developing business and organization in South America. Speaks five languages. C-804.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 34; S.B. in C.E.; S.M. in C.E.; professional engineer's license, New York State; 11 years experience with contractors in field and office on heavy construction; has estimated bridges, roads, and foundations and taken charge of this work in the field; interested in investing some money and joining a small contractor as a member of the firm. C-795.

CONSTRUCTION ENGINEER; M. Am. Soc. C.E.; 38; married; experienced in heavy construction. Airports, runways, hangars, lighting, industrial buildings. Experienced in concrete construction, dams, etc.; municipal engineering, water supply, and sewage disposal; traffic engineering. Available now; location preferred, Southwest. C-797-4011-A-1-San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; married; B.S. in C.E., University of Maryland; desires position on construction of steel and reinforced concrete structures, preferably bridges; 2 years experience on major bridge project as instrumentman on alignment of beam, truss, and girder spans. C-800.

PLANT ENGINEER; Assoc. M. Am. Soc. C.E.; 40; general engineering supervision of maintenance and new construction for plant or large institution; 17 years unusually broad experience in steel, concrete, surveying, gas and electric utility structures, including gas mains, pole lines, right-of-way problems, electrical and mechanical equipment, design, specifications, contracts, purchasing. C-801.

EXECUTIVE

ENGINEER EXECUTIVE; M. Am. Soc. C.E.; 22 years in consulting engineer's office; 12 years, federal engineering; civil, hydraulic, hydroelectric office, and field engineer; technical investigations, reports, design, construction, cost estimates; dams, hydroelectric plants, transmission lines, pipe lines, flood control, buildings. Commercial experience, export and domestic; department manager handling purchases, sales, and claims. C-803.

HYDRAULIC

DESIGN AND HYDRAULIC ENGINEER, Assoc. M. Am. Soc. C.E.; 37; married; B.S. in M.E. with graduate work and legal training; 15 years experience on hydraulic and economic studies, design, cost estimating, and report writing in connection with locks and dams, hydroelectric plants, and flood control projects. Hydraulic turbine testing and design. Available immediately. C-805.

JUNIOR

FOUNDATION ENGINEER; Jun. Am. Soc. C.E.; age 32; married; M.S. degree; 2 years teaching experience; five years in charge of field and laboratory investigations in soil mechanics for major construction projects; 10 years total civil engineering; good theoretical and practical knowledge of settlement, subsidence, slope stability, stress analysis, and model studies; structural engineering background. C-794.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E.; registered in Minnesota; 9 months as resident engineer on power-plant additions project; 3 years drafting and design on all types of bridges, and 6 months on bridge construction. C-796.

JUNIOR ENGINEER; Jun. Am. Soc. C.E.; 23; married; prefers design, sales, surveying, or office work. Location, South America, because of knowledge of Spanish. Available upon notice. C-798.

RESEARCH

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; California license; desires position covering research, planning, statistics, reports on development and economic utilization of land, etc.; writer, speaker, and specialist in public relations. Exceptional experience; available now; location immaterial. C-802.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

CONCRETE DESIGN AND CONSTRUCTION. By W. H. Gibson and W. L. Webb. American Technical Society, Chicago, 1940. 500 pp., illus., diagrs., charts, tables, $8^1/_2 \times 5^1/_2$ in., cloth, $4.75.

This textbook aims to provide a simple, concise treatment covering the composition and properties of concrete, the general theory and design of slabs, beams, columns, etc., and the mixing, transporting, and placing of concrete. Only simple mathematical knowledge is required.

(The) RIGID-FRAME BRIDGE, 2 ed. by A. G. Hayden. John Wiley & Sons, New York, 1940. 285 pp., illus., diagrs., charts, tables, 9×6 in., cloth, $4.50.

The theory of indeterminate analysis is discussed, and detailed calculations are presented for the application of rigid-frame construction to various types of short-span reinforced-concrete, and structural-steel bridges. The principles developed have had considerable use in actual practice, and a chapter on practical points on design and construction is included. Consideration is given to the architecture of short-span bridges.

SEWERAGE AND SEWAGE TREATMENT, 5 ed. By H. E. Babbitt. John Wiley & Sons, New York, 1940. 648 pp., illus., diagrs., charts, tables, 9×6 in., cloth, $5.

This standard textbook provides in one volume a good treatment of the whole field, from the hydraulics of sewers to consideration of industrial wastes. In the present revision certain obsolete processes and practices have been omitted to make room for others now in use or being developed. A collection of problems and a large bibliography are appended.

STRENGTH OF MATERIALS, Pt. 1. Elementary Theory and Problems, 2 ed. By S. Timoshenko. D. Van Nostrand Co., New York, 1940. 359 pp., illus., diagrs., charts, tables, 9×6 in., cloth, $3.50.

The elementary theory contained in this textbook for undergraduates covers analysis of stress and strain, shearing force and bending moment, beam and column theory, torsion and the energy of strain. Moments of inertia of plane figures are worked out in appendixes, and a group of problems accompanies the discussion of each new topic.

STRENGTH OF MATERIALS, 9 ed. By A. Morley. Longmans, Green & Co., London and New York, 1940. 571 pp., illus., diagrs., charts, tables, $9 \times 5^1/_2$ in., cloth, $4.20.

The essential theories of strains and stresses in mechanical and structural elements are presented in this standard work, together with descriptions of testing machines and methods. Considerable revision has been made in the material on fatigue, elastic strength, creep, and other rapidly expanding fields. Illustrative examples accompany each chapter.

SUPPORTING STRENGTHS OF CAST-IRON PIPE FOR WATER AND GAS SERVICE (Iowa Engineering Experiment Station, Bulletin 146, June 1940). By W. J. Schlick. Iowa State College, Ames, Iowa, June 5, 1940. 128 pp., illus., diagrs., charts, tables, 9×6 in., paper, free upon application.

This investigation of cast-iron pipe under field conditions was conducted in cooperation with the American Standards Association. The investigation produced (1) an empirical method for determining the safe combination of external load and internal pressure and (2) safe design values of the strength ratios for pipe laid in various representative manners. The complete experimental data and analytical study are presented.

TECHNICAL DRAFTING, a Text and Reference Book on Graphics. By C. H. Schumann. Harper & Brothers, New York and London, 1940. 793 pp., illus., diagrs., charts, tables, $9^1/_2 \times 6$ in., cloth, $3.50.

This volume has been designed not only as a comprehensive textbook on engineering drafting but also as a professional reference book. The first part presents the elementary principles of the subject. The second part goes intensively into commercial practice in the various branches of engineering, including welded construction and both architectural and topographical drafting. There are many illustrative problems, and certain useful data are contained in an appendix.

WEATHER ANALYSIS AND FORECASTING, a Textbook on Synoptic Meteorology. By S. Petterssen. McGraw-Hill Book Co., New York, 1940. 505 pp., illus., diagrs., charts, maps, tables, 9×6 in., cloth, $5.

This book presents a complete, authoritative treatment of modern methods of weather analysis and forecasting. The author discusses in detail the underlying theories and their application to weather charts and upper-air charts, and offers numerous examples of correct analysis and forecasts. Recent results in the fields of air-mass analysis, frontal analysis, and isentropic analysis are included. There is a bibliography.


CALKING the jointing material in a cast iron bell-and-spigot pipe line is the finishing touch to a structure with a useful life of more than 100 years. To all intent and purpose, a cast iron underground conduit is a permanent installation. Constant improvements in casting methods and metallurgical controls contribute further to the long life of U.S. centrifugally cast and pit cast pipe.
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CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Publications (Except Those of the American Society of Civil Engineers) in This Country and Foreign Lands

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

CONCRETE GIRDER, JERSEY CITY, N. J. Design and Erection Features Mark This Bridge Job. *Ry. Age*, vol. 109, no. 14, Oct. 5, 1940, pp. 475–478. Description of reconstruction of overhead span of Delaware, Lackawanna and Western Railroad at Jersey City, N.J., which incorporated application of asbestos cement plates; new structure embodies two roadways which are separated by center curb; over-all width of structure is 80 ft 6 in.

HIGHWAY, DESIGN. Round-Table Conference, V. S. Murray and E. J. Napier. *Roads & Bridges*, vol. 78, no. 10, Oct. 1940, p. 40. Discussion of respective merits of single deck, divided deck, and twin bridges for dual highways; economic factors that make one type of bridge preferable to others.

NATURAL GAS PIPE LINES. Large Pipe-Line Suspension Bridge Is Constructed by Northern Natural, T. P. Sanders. *Oil & Gas J.*, vol. 39, no. 19, Sept. 19, 1940, pp. 145–146. Description of world's longest single-span pipe line suspension bridge, crossing Missouri River near Sioux City, Iowa, to carry 16-in. gas transmission line on extension of line from South Sioux City, Nebr., to Minneapolis, Minn.; crossing river at height 54 ft above high water level, bridge has total depth of 3,540 ft, with main channel span 1,320 ft long.

PLATE GIRDER, AUSTRALIA. Swan River Bridge, E. W. Godfrey. *Commonwealth Engr.*, vol. 27, no. 11, June 1, 1940, pp. 365–368. Construction of new steel plate girder highway bridge, 720 ft long, over estuary of Swan River, Fremantle, Western Australia; piers and decks are of timber; protection of timber piles against attack by marine organisms.

PLATE GIRDER, ONTARIO. Six-Lane Highway Bridge Over Welland River, A. Sedgwick. *Roads & Bridges*, vol. 78, no. 9, Sept. 1940, pp. 18–19 and 58. Structure 1,000 ft long being constructed, crossing Welland River at Michigan Central Railway at Montrose, Ont., along Queen Elizabeth Way.

PONTOON, SEATTLE, WASH. Massive Concrete Pontoons, R. Barber. *Pac. Bldr. & Engr.*, vol. 46, no. 31, Aug. 3, 1940, pp. 41–43. Procedure followed in building, launching, and placing of pontoons, which form Lake Washington floating bridge, described in many previously indexed articles.

RAILROAD. Railway Bridges Over Albert Canal in Belgium, L. Wiener. *Ry. Gas.*, vol. 72, no. 23, June 7, 1940, p. 804. Some notes on large single-span railway bridges of Vierendeel and lattice girder type, built by Belgian National Railways over new Albert Canal.

RAILROAD CROSSINGS, ELIMINATION. Pre-Cast 135-Ton Concrete Slabs on C.N.R. Subway, C. P. Disney. *Roads & Bridges*, vol. 78, no. 9, Sept. 1940, pp. 13–15 and 56. Construction of deck of grade separation structure carrying railroad across highway at Val Royal, Montreal, comprising four pre-cast reinforced concrete slabs, each weighing approximately 135 tons; slab casting methods; falsework; erection procedure.

STEEL TRUSS, FAILURE. Causes of Welded Bridge Failures: Recent Experience in Belgium and Germany. *Ry. Gas.*, vol. 72, no. 24, June 14, 1940, pp. 830–832. Details of three welded bridges over Albert Canal in Belgium which failed; bridge failures at Zoological Gardens Station, Berlin, and at Ruedersdorf Bridge, near Berlin.

STEEL TRUSS, RAISING. Columbia River Bridge Raised 45 Ft. *Eng. News-Rec.*, vol. 125, no. 15, Oct. 10, 1940, pp. 464–465. Method of raising, for vertical distance of 45 ft, steel truss cantilever highway bridge, 4 miles upstream of Bonneville Dam, Ore., consisting of two side or anchor spans 211 ft long and center span of 705 ft; suspended section of main span was dismembered and removed in reverse erection order; cantilever sections were raised on jacks as supporting piers were progressively built up to required height.

BUILDINGS

STEEL, DESIGN. Design Economy by Connection Restraint, B. Johnston and R. A. Hechtman. *Eng. News-Rec.*, vol. 125, no. 15, Oct. 10, 1940, pp. 484–487. Theoretical mathematical discussion of restraint values of beam-column connections in design of multi-storied steel building frames; proposed method of design proportioning connection for semi-fixed end moment which would occur if columns did not rotate, and proportioning beam for maximum center moment which occurs when columns do rotate; analysis of semi-rigidly connected frame or critical loading condition. Bibliography.

CITY AND REGIONAL PLANNING

GERMANY. Die staedtebauliche Neugestaltung der Hansestadt Koeln, M. E. Feuchtinger. *Verkehrstechnik*, vol. 20, no. 23, Dec. 5, 1939, pp. 517–521. Recent city planning and construction in Hansa City of Cologne; automotive transportation and city construction; traffic aspects of city; influence of German superhighway system. (To be continued.)

GREAT BRITAIN. Reconstruction and Town and Country Planning. *Nature* (London), vol. 146, no. 3702, Oct. 12, 1940, pp. 479–481. Attention directed to conference in Great Britain called to consider what immediate action could be taken to promote planning of social environment on national scale; among new directions for investigation, as prelude to reconstruction, are problems raised by evacuation and dispersal of industry, through development in rural areas and elsewhere of immense war industries and undertakings.

CONCRETE

AGGREGATES. Friant Dam—Aggregate Plant Design Features Simplicity and Efficiency. *Western Construction News*, vol. 15, no. 9, Sept. 1940, pp. 304–307. Features of aggregate plant which will produce about 3,500,000 tons of sand and gravel required for concrete of Friant Dam being constructed on San Joaquin River about 20 miles northeast of Fresno, Calif.; gravel crushing and screening; fine aggregate processing; washing and grading of aggregate in 90-ft open steel-frame screening tower; gold reclaiming plant.

AQUEDUCTS, LINING. Aqueduct Barge Fleet—Canal Relined by Crews on Floating Platforms. *Western Construction News*, vol. 15, no. 10, Oct. 1940, pp. 331–333. Use of self-propelled barges in relining of 2-mile section of concrete-lined canal, at upper end of Los Angeles Aqueduct in Owens Valley, with 5 in. of concrete.

BINS. Thin Facing of Stone Concrete Applied by Vacuum Process. *Construction Methods*, vol. 22, no. 10, Oct. 1940, pp. 64–65 and 81. Refacing 3,600 sq ft of vertical surfaces on two ash bunkers at Bridgeport, Conn., power station of United Illuminating Co., by putting thin facing in place with panel forms which use atmospheric pressure to hold them in position, and which are ready for stripping in 15 min.

BUILDINGS. Early-Strength Cement Aids High-Speed Construction of Foundry Extension. *Construction Methods*, vol. 22, no. 9, Sept. 1940, pp. 42–44, 96, 98, and 100–101. Erection, in 70 working days of quarter-million dollar foundry extension for Bullard County, Bridgeport, Conn.; use of high-early-strength concrete for first floor; floor design; concrete forms; mixing and placing.

CONSTRUCTION, COLD WEATHER. Proper Equipment Is Key to Success in Winter Concreting. *Concrete*, vol. 48, no. 10, Oct. 1940, pp. 14 and 16. Special equipment needed in winter concreting is considered.

CONSTRUCTION, VIBRATING. Advantages of Vibration, H. E. McKeen. *Roads & Bridges*, vol. 78, no. 10, Oct. 1940, pp. 81 and 111. Review of recent comparative studies of vibrated and non-vibrated mixes designed with same aggregate; economics of vibrating; causes of adverse criticism.

FLOORS. Build Reputation as Contractor Specialist on Concrete Floors. *Concrete*, vol. 48, no. 9, Sept. 1940, pp. 16 and 18. Several methods of construction of concrete floors are illustrated and described.

HOUSE CONSTRUCTION, CALIFORNIA. Mass Production Methods. *Construction Methods*, vol. 22, no. 9, Sept. 1940, pp. 56–59. Description of mass production methods used in construction of 607 low-cost family dwelling units on Carmelitos housing project in North Long Beach, Calif.

PILES. Steel Forms Speed Casting of 4600 Concrete Piles. *Western Construction News*, vol. 15, no. 9, Sept. 1940, pp. 315–316. Method of casting reinforced concrete piles at Naval Fleet supply base in Oakland, Calif., using collapsible forms featuring special bracing devices, to assure true alignment, and simple clips to connect section lengths and tapered ends; stripping and replacing forms; placing of reinforcing steel; pouring of concrete.

REINFORCEMENT, WELDING. Welding 2-In. Sq. Bars for Pit River Bridge Piers. *Western Construction News*, vol. 15, no. 9, Sept. 1940, pp. 302–303. Method of splicing reinforcement bars with butt welds of special design, requiring pre-heating of bar ends.

DAMS

CONCRETE ARCH, MAINTENANCE AND REPAIR. Repairs to Burrinjuck Dam. *Commonwealth Engr.*, vol. 27, no. 11, June 1, 1940, p. 385. Description of construction plant for placing bituminous sheath 4 ft wide in wall of Burrinjuck concrete arch dam, Australia, extending from top to bottom at estimated cost of £1,800,000.

CONCRETE, FORMS. Wood Panel Forms for Building Concrete Dams—IV and V, H. P. Maxton. *Construction Methods*, vol. 22, nos. 9 and 10, Sept. 1940, pp. 62–63, 90, and 94–96, and Oct., pp. 66–67, 94, and 96–98. Organization and procedure of time studies of construction processes, particularly those involving wood panel forms; initial cost of panels; cost-keeping methods; form cost report; formwork chart.

CONCRETE GRAVITY, CALIFORNIA. Concreting Plant at Shasta Dam Started on 6,000,000 Cu Yd Job. *Western Construction News*, vol. 15, no. 10, Oct. 1940, pp. 336–339. Progress report of concrete construction at Shasta Dam, Calif.; aggregate storage and handling; stockpile storage; conveyor system; concrete mixing plant; transferring concrete from mixing plant to 8-cu yd buckets; major units of equipment.

CONCRETE GRAVITY, CALIFORNIA. Friant Dam, H. W. Young. *Explosives Engr.*, vol. 18, no. 9, Sept. 1940, pp. 272–275. Report on initial stage of construction of Friant concrete gravity dam across San Joaquin River, Calif., 320 ft high and 3,430 ft long at crest; drilling and blasting; diverting San Joaquin; concreting equipment.

EARTH, AUSTRALIA. Bottom Dump Barges Installed at Hume Reservoir, E. D. Shaw. *Commonwealth Engr.*, vol. 27, no. 11, June 1, 1940, pp. 369–370. Description of special barges, 80-cu yd capacity, designed for placing 300,000 cu yd of granite rubble on upstream face of earthern embankment of Hume Dam, Victoria, Australia, having length of 2,500 ft and average height of 125 ft.

EARTH, OREGON. First Dams Built for Willamette Basin Project. *Western Construction News*, vol. 15, no. 10, Oct. 1940, pp. 340–342. Construction of two earth-fill dams of Willamette River project, Oregon; Fern Ridge Dam, 44 ft maximum height, 6,360 ft long, and Cottage Grove Dam, 95 ft maximum height, 2,095 ft long.

FOUNDATIONS. Foundation Exploration at Kentucky Dam, A. V. Lynn and R. F. Rhoades. *Eng. News-Rec.*, vol. 125, no. 15, Oct. 10, 1940, pp. 480–483. Methods used in intensive exploration of site of Kentucky Dam, largest of all Tennessee Valley Authority projects, which will be combination concrete and earth-fill structure 8,650 ft long and will create reservoir 73 ft above

present river level; angle borings; permeability tests in field; overburden drilling; rock drilling.

FOUNDATIONS. Geological Aspects of Colorado-Big Thompson Project, R. L. Heaton. *Mines Mag.*, vol. 30, no. 5, May 1940, pp. 257–262, and June, pp. 305–312. Summary of features of project involving short tunnels in sedimentary or metamorphic rocks, transmountain tunnel in metamorphic and igneous rocks, and dam site foundations consisting of various rock formations, clays, or glacial moraines; three possible routes for Continental Divide tunnel investigated; engineering aspects; Green Mountain Dam; Granby Dam site; Soldier Canyon and other Eastern Slope dam sites; conduit tunnels.

RESERVOIRS, OUTLETS. Outlet Works at Grand Coulee Dam, L. V. Froage. *Reclamation Era*, vol. 30, no. 8, Aug. 1940, pp. 215–218. Description of outlet works of Grand Coulee Dam consisting of 60 conduits, each $8^1/_2$ ft in diameter; designed to operate at maximum head of 250 ft; gate operation; trashrack structures and conduit openings; installation of gates.

ROCK FILL, WASHINGTON. Progress at Mud Mountain Dam. *Western Construction News*, vol. 15, no. 9, Sept. 1940, pp. 299–302. Progress report on initial stage of construction of Mud Mountain flood-protection rock-fill dam near Tacoma, Wash., having maximum height of 425 ft above bedrock, crest length of 700 ft; driving and lining of diversion tunnel; spillway excavation; preparation of dam site; principal items of equipment.

TUNNELS

WATER SUPPLY, CALIFORNIA. Mono Basin Project. *Engineer*, vol. 169, nos. 4406 and 4407, June 21, 1940, pp. 548–549, and June 28, pp. 566–567 and 572. Illustrated description of project for Los Angeles water supply under way since 1934, embracing diversion canal with its heading in Lee Vining Creek; Great Lake reservoir, gravity line consisting of conduit, pressure pipe, and tunnels; Long Valley reservoir; driving of Mono Craters tunnel.

WATER SUPPLY, NEW YORK. Driving Tunnel Beneath Hudson River, R. G. Skerrett. *Compressed Air Mag.*, vol. 45, no. 9, Sept. 1940, pp. 6227–6232. Illustrated description of work carried out on Roundout-West Branch tunnel of Delaware Aqueduct, which passes underneath Hudson River 600 ft below surface; for ventilating Shaft 6 and two tunnel headings driven from it, there are installed above ground two Ingersoll-Rand Type FS-575 turboblowers each driven by 100-hp, 2,300-v motor; air for operating pneumatic equipment supplied by surface compressor plant composed of two Ingersoll-Rand PRE-2 machines.

WATER PIPE LINES

CORROSION. Problems Inside Water Pipes, H Nix. *Textile World*, vol. 90, no. 9, Sept. 1940, pp. 80–81. Leading causes of trouble inside water mains and principal methods employed to correct and prevent these troubles.

CROSS CONNECTIONS. Cross Connections and Plumbing Testing Laboratory in New Bedford Vocational School, E. J. Sullivan. *New England Water Works Assn.—J.*, vol. 54, nol 2, June 1940, pp. 179–185. Review of cross-connection problems in service installations; description of special testing laboratory in Vocational School of New Bedford, Mass., for determining adequacy of plumbing fixtures and connections.

SOILS, CORROSIVE PROPERTIES. Soil Corrosion of Metals and Cement Products. *Water & Water Eng.*, vol. 42, no. 529, Sept. 1940, pp. 324–327. Map showing distribution of geological formations of England suspected of causing corrosion of metals and cement products; description of formations; conditions causing corrosion.

STANDPIPES. Useful Life of Iron and Steel Standpipes, C. W. Sherman. *New England Water Works Assn.—J.*, vol. 54, no. 2, June 1940, pp. 149–154. Study of tabulated data on service life of 111 iron and steel standpipes in New York and in New England states, leading to conclusion that their average probable life is 45 years.

WATER RESOURCES

UNDERGROUND, ARID REGIONS. Forecasting Ground-Water Supply in Deserts, G. E. P. Smith and L. J. Booher. *Pan-American Geologist*, vol. 74, no. 2, Sept. 1940, pp. 94–98. Discussion of factors in forecasting seasonal water supply in arid regions, with special reference to irrigated sections of southern Arizona; significance of winter snow course surveys; sublimation of snow; rational method of forecasting water supply of Arizona valleys. Before Am. Assn. for Advancement of Science.

WATER TREATMENT

CHLORINATION. Observations on Break-Point Chlorination, A. E. Griffin. *Am. Water Works Assn.—J.*, vol. 32, no. 7, July 1940, pp. 1187–1190. Review of recent American experience with break-point chlorination for control of tastes and odors in water supply.

EXPERIMENTAL. Pilot Water Treatment Plant for Study and Research, G. E. Barnes. *Water Works Eng.*, vol. 93, no. 19, Sept. 11, 1940, pp. 1181–1182 and 1185. Description of experimental water treatment plant of department of civil engineering, Case School of Applied Science; construction features; chemical feeds; sedimentation basins; filters; operating considerations.

FILTRATION PLANTS, CHICAGO. Chicago's First Filtration Plant to Serve Half of City's Area. *Concrete*, vol. 48, no 7, July 1940, pp. 3–4. Plant is being constructed as major portion of project estimated to cost $20,000,000; in addition to plant, project includes breakwater built as rubble-mound structure 2,260 ft long; bulkhead inclosing filtration plant, new beach, and park fill of 115 acres, filtration plant tunnels, and substructure of plant; features of project described; 230,000 cu yd of concrete being distributed by pipe-line system.

FILTRATION PLANTS, MILWAUKEE. Tuning-Up Large Filter Plant, J. Kerslake. *Eng. News-Rec.*, vol. 125, no. 11, Sept. 12, 1940, pp. 339–340. Abstract of paper, before American Water Works Association, on initial operation of 200-mgd Milwaukee water filtration plant involving certain additions and replacements of equipment, as well as adjustments.

FUNDAMENTALS. Fundamentals of Water Treatment, A. C. Beyer. *Western City*, vol. 16, no. 8, Aug. 1940, pp. 19–21 and 27. Elementary discussion of principles of water treatment methods.

LANCASTER, OHIO. Water Treatment, W. W. Graf. *Am. City*, vol. 55, no. 9, Sept. 1940, pp. 54–56. Operation of water treatment plant of Lancaster, Ohio, serving population of 22,000; iron removal by aeration and filtration; softening by upward-flow beds of zeolite; zeolite softening units; chlorine and pH control; cost data.

PLANTS, CALIFORNIA. Softening Plant of Metropolitan Water District of Southern California—III, C. P. Hoover, J. M. Montgomery, and W. W. Aultman. *Water Works & Sewerage*, vol. 87, no. 8, Aug. 1940, pp. 347–350. Lime reclamation, its place in economy of softening and alleviation of sludge disposal problem; Estabrook and Hoover processes of lime reclamation in water softening; methods of avoiding magnesia build-up; advantages of lime-zeolite softening; calcining furnace. (Concluded.)

PROBLEMS. Active Problems in Water Purification, P. Hansen. *Am. Water Works Assn.—J.*, vol. 32, no. 7, July 1940, pp. 1118–1136. Review of recent water treatment experience in United States; research on laboratory determination methods; developments in use of chlorine; studies on coagulation; corrective measures for corrosion; sludge disposal; sludge reclamation and re-use of lime; use of ion-exchange materials, sulfur dioxide, and aqueous ammonia; studies on flocculation; design of sedimentation basins; filter bottoms; filter sand problems and studies. Bibliography.

RECONSTRUCTION. Old Softening Plant Goes Modern, E. L. Filby. *Eng. News-Rec.*, vol. 125, no. 5, Aug. 1, 1940, pp. 170–172. Modernization program undertaken by Owensboro, Ky., in revamping 1911 water softening plant to meet present-day requirements; gravel-wall wells; "high-rate" filters; mechanical equipment for sludge removal.

SOFTENING PLANTS, ANN ARBOR, MICH. Operation of Ann Arbor Softening Plant, H. E. McEntee. *Am. Water Works Assn.—J.*, vol. 32, no. 9, Sept. 1940, pp. 1600–1618; see also *Water Works & Sewerage*, vol. 87, no. 9, Sept. 1940, pp. 391–400. Comparative discussion of methods of water treatment for new water softening plant of Ann Arbor, Mich., including following: conventional treatment, split treatment, split treatment and return of primary sludge, and split treatment and return of secondary sludge; operation difficulties.

SOFTENING PLANTS, ST. PAUL, MINN. Softening Water for St. Paul, L. N. Thompson. *Water Works Eng.*, vol. 93, no. 19, Sept. 11, 1940, pp. 1159–1164 and 1212. Enlargement of old water filtration plant of St. Paul, Minn., and its conversion into water softening plant of 90-mgd ultimate capacity; description of new plant; course of water during process of purification; filter design; construction and operation of new plant.

TASTE AND ODOR REMOVAL. Taste and Odor Control on Lake Michigan, N. A. Thomas. *Am. Water Works Assn.—J.*, vol. 32, no. 7, July 1940, pp. 1183–1186. Recent experience of water works of Milwaukee, Wis., and other municipalities along west shore of Lake Michigan with taste and odor control of their water supplies; relationship between micro-organisms and threshold odor.

TEXTILE MILLS. Increasing Filter Efficiency by Proper Care, H. Nix. *Textile World*, vol. 90, no. 8, Aug. 1940, pp. 62–63. Article discusses principal factors affecting efficiency of filters and describes measures which should be taken to avoid difficulties and to correct troubles if they occur; particular stress placed on proper methods of backwashing and on cleaning of sand by newer chemical processes.

Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

"How to Choose a Slide Rule"

by Don Herold

THIS HUMOROUS PUBLICATION explains for the first time the difference between the various types of slide rules available, in straightforward salty language. Although written primarily for students in engineering colleges, this two-color, illustrated booklet of 24 pages contains slide rule information of interest to the entire engineering profession. Free upon request. Keuffel & Esser Co., Hoboken, N.J.

New Fittings for J-M Electrical Conduit

A COMBINATION OF electrical conduit fittings that can be handled in the same manner as a mitred stove-pipe elbow was recently announced by Johns-Manville. A box of these fittings with a shipment of Transite asbestos-cement ducts prepares the contractor for practically any change in direction with a minimum of lost time and materials, according to the company's announcement. Consisting of curved segments, deflection couplings and sweeps, the fittings facilitate the by-passing of obstructions not anticipated in the design and overcome the expense and delay of special fittings.

The fittings permit changes in direction in one or more planes in a very short distance; also the assembly of a spiral type of bend where it is necessary to change direction slightly in one plane and then swing into another plane. Long radius changes of direction can be made when two or more of the fittings are separated by straight sections of duct.

These fittings are of asbestos-cement composition and are made to fit both Transite asbestos-cement conduit, which is designed for use without concrete, and the thinner-walled Transite Korduct, used in the conventional concrete envelop.

Drafting Tables

TWO MODERN DRAFTING tables, the Primo Metapost and the Metapost, are announced by The Frederick Post Co., P. O. Box 83, Chicago, Ill.

Both tables are built of satin chrome tubular steel with tops of selected soft pine. Both are readily and easily adjustable to working surfaces from $35^1/_2$ in. to 43 in. with tops which may be tilted from front to back at an angle of sixty degrees. Reference shelves may be attached to either table.

These new Post tables, ranging in price from $40.00 to $76.00, are available in eleven table top sizes, from 31 in. by 42 in. to 48 in. by 96 in.

Electrode Selector Chart

TO SIMPLIFY THE selection of the proper electrode for the job at hand, Air Reduction has announced the publication of an Electrode Selector Chart.

Under separate guides, listed according to the metal to be welded, the chart enumerates such things as the suggested type of electrode, welding procedure and recommended voltage and current values. Attractively designed, the Electrode Selector Chart is bound so that it can be hung either on the welding machine itself or on an adjacent wall within easy reach of the operator. Copies may be obtained by writing to Air Reduction, 60 East 42nd St., New York, N.Y.

Mortar and Plaster Mixer

CHAIN BELT COMPANY announces a new 6 cu ft Rex Mortar and Plaster Mixer, completely redesigned to incorporate many new features. Primary among these are the adjustable steel scraper blades, air cooled power and a new trouble-free paddle shaft seal.

The new adjustable steel scraper blades make certain a clean drum after every discharge. When wear occurs the scraper can be set to clean the drum sides as easily as when the machine was new. The one cylinder 4 hp gasoline engine is air cooled for lighter weight and easier operation. The new paddle shaft seal has a finely ground-surfaced collar revolving in contact with a Neoprene ring which in turn is backed by a chamber packed with grease under pressure. Dirt and grout cannot seep past these seals.

In addition, there are a number of other refinements which have been made on this mixer. The drum lock is fool-proof; the machine can be easily towed; the engine cover opens away from the shoveling side and protects the engine and gear box from sand and dirt; the discharge lip is constricted to prevent undue splashing; the controls are simple and within easy reach of the operator; the low shoveling height saves time and back work.

For further information on this machine, write to the Chain Belt Company, 1600 West Bruce St., Milwaukee, Wis. Ask for Bulletin No. 383.

Richmond Screw Anchor Expands Its Plant

The Richmond Screw Anchor Co., Inc., manufacturers of concrete form tying devices of all kinds, has recently moved to 816-838 Liberty Ave., Brooklyn, N.Y. In this new home, the Company has trebled its office, manufacturing, shipping, and storage space.

Double Bucket Carryall

Designed to give increased yardage with D8 tractor power, R. G. LeTourneau, Inc., has introduced the Model LU Carryall cable-controlled scraper with a struck capacity of 15 and a heaped capacity of 19 cu yds.

The double bucket feature incorporated in the Model LU gives the effect of loading two small Carryalls successively. After the first bucket is loaded to capacity, it is permitted to travel back on rollers, thus reducing loading resistance and giving larger possible loads for expended tractor effort. The second or front section of the bowl is then easily loaded with the D8 tractor power. In spite of the large capacity bowl the cutting edge is only 8 ft 6 in. wide.

Positive, wipe-out ejection tailgate gives accurate control of spread, eliminating the necessity for secondary spreading tools, and empties the bowl completely and quickly of the stickiest materials. Single dead-ended cable on either side of the bowl pulls the tailgate from the vertical load center. To keep the sheaves entirely free from dirt, cable is dead ended on the apron and a sliding block sheave assembly mounted upon springpipe. In order to make the Model LU adaptable for all types of job conditions, it may be equipped with a large variety of tire sizes.

Paving Vibrator

Blaw-Knox Co., Pittsburgh, Penna., has developed a concrete vibrator of the surface type which may be operated in conjunction with either its new paving spreader or its finishing machine.

The vibrator pan is made of abrasion resistant steel, assembled with high tensile alloy steel bolts and lock nuts. While of light weight construction, the pan has a sufficiently deep section to obtain strength and rigidity. The vibrators consist of unbalanced rotors mounted on the pan, two used for models accommodating up to 12 ft pavement widths and four on the full width machines. The center of gravity of the rotating member is readily adjustable to vary the amplitude of the vibration; the frequency, normally 4,200 per min, is likewise adjustable.

INDEX OF PRODUCTS

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No. 1

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